

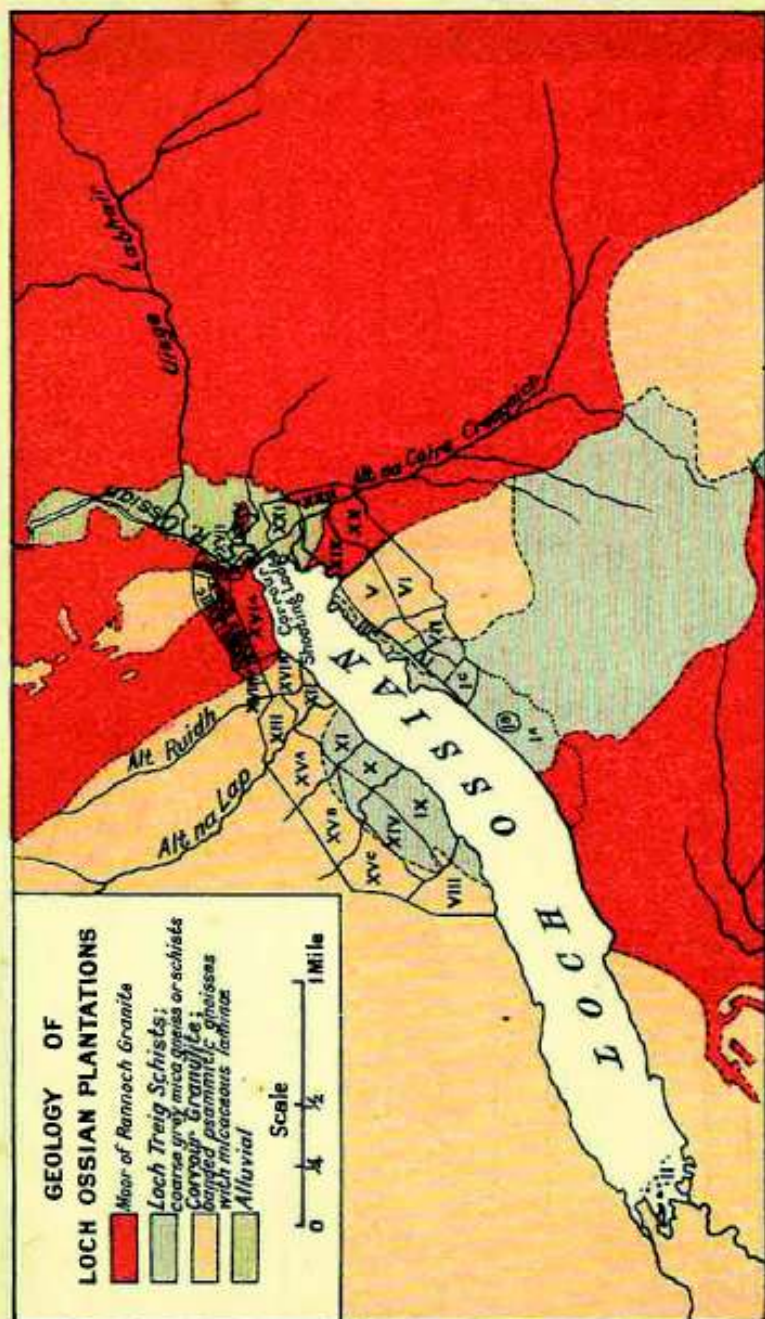
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LOCH OSSIAN PLANTATIONS

AN ESSAY
IN AFFORESTING
HIGH MOORLAND

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MCMXXIX



LOCH OSSIAN PLANTATIONS

AN ESSAY
IN AFFORESTING
HIGH MOORLAND

MCMXXIX

One hundred and fifty copies
privately printed

TO
C. S. M. AND A. S. M.

Fouler le gazon au pied d'un vieux chêne,
 Écoutant des oiseaux le délicieux ramage,
 C'est commun: donnez-moi le pays où l'on nous mène
 Écarter le gazon pour trouver de l'ombrage.
 Puisque tout paraît plus beau dans la distance,
 Puisque l'espoir vaut bien la chose acquise,
 Vive le pays où les arbres de l'Espérance
 Font de Glenquoich une sorte de Terre Promise.

Glenquoich Game Book.

The larches and silver firs in the plantation at Glenquoich which inspired these lines some seventy years ago are now a hundred feet or more in height.

LOCH OSSIAN PLANTATIONS.

NAME.	COMPARTMENT.	ACRES.	ELEVATION.
LEITER DHURH, (93.7 acres)	IA.	84.6	1269-1650 ft.
	IB.	9.1	1280-1490 ..
ISLANDS, - - -	II.	2.5	1269-1280 ..
BOAT HOUSE PLANTATION, (118.3 acres)	III.	31.7	1269-1335 ..
	IV.	17.9	1325-1510 ..
	V.	26.4	1275-1510 ..
	VI.	24.9	1410-1680 ..
	VII.	17.4	1460-1665 ..
LAP PLANTATION, (273.3 acres)	VIII.	35.3	1269-1460 ..
	IX.	36.4	1269-1455 ..
	X.	19.5	1269-1460 ..
	XI.	23.4	1269-1460 ..
	XII.	15.2	1269-1400 ..
	XIII.	16.6	1360-1555 ..
	XIV.	38.2	1365-1555 ..
	XVA.	30.6	1360-1555 ..
	XVB.	26.6	1460-1560 ..
	XVC.	31.5	1455-1565 ..
MEALL GLASUAIN PLANTATION, (85.2 acres)	XVIA.	22.0	1269-1365 ..
	XVIB.	13.0	1269-1420 ..
	XVII.	5.5	1269-1285 ..
	XVIIIA.	5.8	1270-1335 ..
	XVIIIB.	5.8	1300-1430 ..
	XVIIIC.	8.1	1305-1500 ..
	XVIIID.	12.7	1315-1435 ..
	XVIIIE.	8.0	1429-1500 ..
COIRE CREAGACH PLANTATION (36.6 acres),	XVIII.	4.3	1365-1485 ..
	XIX.	24.0	1275-1400 ..
MEALL NATHRACH PLANTATION (34.6 acres),	XX.	12.6	1345-1430 ..
	XXI.	13.3	1275-1320 ..
BIRCH CLUMPS, - -	XXII.	21.3	1300-1455 ..
	XXIII.	4.6	1269-1305 ..
THE KNOBBIES, - -	XXIV.	3.5	1265-1280 ..
STRATHOSSIAN PLANTATION	XXV.	2.5	1205-1220 ..
LUIB NA CLACH PLANTATION.	XXVI.	1.0	c. 1270 ft.
TOTAL, -		655.8 acres	

LOCH OSSIAN PLANTATIONS

INTRODUCTORY NOTE

THESE plantations, intended to improve the landscape and afford shelter for deer, were begun without much consideration. They all lie above the 1250 ft. contour. The soil is for the most part poor and covered with peat. The first trees were planted in 1892 and the first regular enclosure was made the following year.

The earlier planting was restricted to such parts of the ground enclosed as were not supposed to require draining. The result, though very far from successful, had a certain interest in view of the increasing belief in afforestation. Since 1925 a number of experiments have been made—largely based on similar work in Belgium—in order to find out whether it is possible to convert poor moorland soil into forest at this altitude in Scotland. In recent years the main object has been the conversion of the pine plantations into spruce.

The war interrupted the planting programme, but the experimental work continued. The value of the latter has been much enhanced by the national scheme of afforestation adopted since the war. The problem of rendering productive areas now almost useless except for sport, attracts both forester and politician. It has proved impossible to acquire large planting areas in Scotland which do not include such land. This has led the Forestry Commission to institute special inquiries into the relation of peat to tree growth. The research officers have made good use of these plantations, and their visits have been a great help to us. Lucky the hobby which finds such justification and encouragement in these difficult times.

Since the appearance of the ground before planting has already been changed and will be completely transformed if the woods come to anything, it must be noted that the pasture enclosed before the war was distinctly inferior to much that adjoins it, such for instance as the slopes of Strathossian or Leitir Dhubh, or the face of Beinn na

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Lap beyond the enclosure. Almost every acre needed some preparation before planting. Even on steep slopes the peat was so tough and tight that sooner or later it had to be cut through. The later additions (XVIIIa, XVIIIb, XVIIIc, and Ib) contain decidedly better soil, but even here more than half the ground had to be drained.

It is doubtful whether forestry can ever pay under these conditions even when they are met with perfected science. Certainly from these plantations with all their mistakes no profit need be expected, even though they occupy ground which is practically worthless. No account of the total expense is therefore taken in these notes, but the cost per acre of various methods of planting is recorded wherever possible.

Mr. John Boyd, Forester at Pollok, and afterwards Crown Forester at Inverleiver, superintended the work till 1905. Since then Mr. Simon Cameron has been in charge. No one who knows him will need to be reminded how much the plantations owe to his zeal, energy, and keen observation.

The bulk of the plantations are included in a single deer fence which surrounds the east end of the loch. It is forked where it joins the water, an effective defence against deer, which are reluctant to trust themselves between two fences. Deer occasionally get in, but thanks to the lively interest taken in the trees by the head stalker, Mr. Duncan Robertson, and his predecessor, Mr. Duncan Ferguson, there has been very little damage. A trap (XVIIIe) by which the deer can escape but not enter was constructed on Mr. Robertson's advice, and has proved effective.

The Roman figures refer to the compartment numbers. The awkward numbering is due to the need of preserving the numbers used in the 1913 edition of these notes and in various reports.

Girth measurements are taken over bark at 4 ft. 3 in. above the ground.

J. S. M.

LOCH OSSIAN PLANTATIONS¹

GENERAL DESCRIPTION¹

Location.—The plantations lie around the north-east half of Loch Ossian, which is situated in the S.E. corner of Inverness-shire, between the high hills of Carn Dearg (3080 ft.) and Beinn na Lap (3066 ft.).

Latitude, - 56° 46'—56° 47½' N., and
Longitude, - 4° 36'—4° 40' West.

Topography.—The surface of the loch lies at 1269 ft. above datum, and the water surface is 3¼ miles long by about a third of a mile in breadth. The loch is held up at either end by an accumulation of morainic drift of considerable thickness, through which at the N.E. end the present outflow stream is cutting a way into Strath Ossian.

Loch Ossian is closely circled by steep and high hills to the N.E. and S., usually rising to 3000 ft. The hills to the west of the loch lie some two or three miles back.

Drainage.—The natural drainage appears to be good on the whole, but, as usual under similar conditions, hollows and flats occur, and especially so on the valley bottom, where drainage is difficult and where peat accumulates.

Exposure.—The area is fully sheltered from all directions except S.W. and N.E. The evidences of exposure in the plantations show that the direction of greatest wind pressure varies over the area. Some parts are most exposed to winds sweeping up Strath Ossian, and others to winds blowing in from the west. On the whole, the area may be described as fully sheltered.

¹ The following paragraphs are quoted from a Report made by Dr. Mark Anderson for the Forestry Commission in June, 1926.

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Climate.—Records of rainfall are available for the years 1922, 1923, and 1924 for Corroul Lodge, 1260 ft. and Strath Ossian, 1180 ft. The rainfall for these years was 65'32, 91'83, and 75'76 in. for Corroul, and 64'48, 81'30, and 68'79 for Strath Ossian. As the years 1923 and 1924 were both years of abnormally heavy rainfall, these figures do not give reliable means. The longer records for Rannoch, Cam Bridge, and Dalnaspidal give 51'42, 68'04, and 59'09 in. respectively. It may thus be assumed that the mean annual rainfall is from 60 to 65 in.²

Low temperatures often occur for long spells. Snowfall is often heavy, and snowbreak and severe blizzards occur.

Geology.—Three important rocks occur in this area. The first is a massive pelitic gneiss, very rich in biotite, classed under the Loch Treig Schists. It is coloured mauve on the accompanying map. The second is a quartz-granulite, the Corroul Granulite, coloured buff on the map. The third is the Rannoch Granite, which is coloured red on the map. This granite is specially rich in the ferro-magnesian minerals, and poor in quartz. On weathering, it should provide a superior type of soil to, say, the Cairngorm Granite. The soils from the Loch Treig schists are probably of somewhat better quality, while those from the Granulite will be distinctly poorer.

Glacial Geology.—Extensive morainic deposits, however, cover these rocks over most of the lower ground on either side of the loch (*see map*). The granite does not outcrop anywhere within the plantations, the Loch Treig Schists only in two small areas in Compartments III, IV, and VII. An important outcrop of Granulite occurs, however, in Compartments III, IV, V, VI, and VII, due to the superior hardness of this rock.

The composition of the moraine mounds is probably fairly uniform, except that, owing to the ice-carry being from west to east, there may be a larger content of rock

² The average at Corroul for seven years ending 1928 works out at 76 in. The true average may therefore be as high as 70 in.

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fragments east of the boundaries from the rock lying west of these. These mounds form the numerous conspicuous knobbs over the lower ground, and the material forming them seems to be relatively loose and gravelly, with the result that the tops have been weathered and leached, although the sides may still be relatively fertile. The hollows and flats between the mounds are now mostly peat-covered. It appears that a definite ground-moraine or boulder till of a stiff stony nature is present below most of the moraine-covered ground, on which, no doubt, many of the peat-flats have been formed.

Although rock outcrops are rare in the lower ground, the general effect of the presence of the exposed solid rocks in the high-lying ground is well marked. For thousands of years past these high-lying rock areas have been weathering and providing a supply of mineral matter in the hill-water, according to their composition and rate of weathering. This water, descending into the moraine material and drift below, has exercised a marked effect, as may be imagined, on the rate of leaching in these mounds, and especially on the mineral content of the lower slopes of the mounds and of the intermediate hollows and flats. So that, although there certainly is no clear-cut line of demarcation between adjacent solid rock areas, one would expect much better soil conditions generally on the lower ground over the Loch Treig Schists and their eastern margins and over the granite than over the Granulite and its eastern margins. Further, the difference in condition would be most marked on the lower slopes, wherever the descending hill-water is forced to come to the surface or near it.

Alluvium and Peat.—There is an extensive area of alluvium around the Lodge, which is covered with peat in some parts. This alluvium is probably mainly granite wash and therefore of a fertile nature. The peat should therefore be, and is, of superior quality.

A great deal of the ground is peat covered. The peat is not, however, by any means uniform in quality or character. Where the supply of mineral matter in the

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surface water has always been low, that is, over the Granulite, the deepest and worst peat types occur. Where it has been higher, *e.g.*, over the Schists and granite, the shallowest and better types occur on the whole. Here, as elsewhere in the Highlands, peat is often absent over the schist area in situations similar to those over the granulite or quartzite, where it is abundant. On the summits of moraine mounds, over all three rocks, bad peat may occur, for these are beyond the influence of the descending surface-water, and may be extensively leached.³

Temperature.—The very low temperatures occasionally experienced at lower altitudes do not occur here, but the mean temperature in both summer and winter is several degrees lower than that between sea level and, say, 500 ft. The winter is consequently less broken, which is an advantage to many plants, including several rhododendrons which can hardly be kept alive at 100 ft. in East Renfrewshire. On the other hand, the growing period is short, and some otherwise hardy plants, such as the Japanese larch, often fail to ripen their wood. The low temperature also intensifies two scourges from which the native pine suffers more than any other tree—snow break and blizzards. They usually occur in spring, and sometimes, as in 1919 and 1927, as late as April.

Ancient Forests.—The roots found in the moss here up to 2000 ft. are all of the native pine. There is no record of the cause or date of the disappearance of these forests. On this estate not a single pine has survived within living memory. The last remnant may have been in Coire a Lochan, whose tarn still bears the name of Lochan a Guibhais. The nearest survivors are at Dall⁴ on Loch Rannoch, at Ardverikie on the south side of Loch Laggan, and in the Cranachan Wood near Loch Tulla. Ritchie, in his *Animal Life in Scotland*, discusses the

³ The quotation from Dr. Mark Anderson's Report ends here.

⁴ A wind fall in the Black Wood of Dall supplied the timber for the panelling and ceilings of the ground-floor rooms in Corroar Lodge.

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possible agents which may have destroyed the forests—a change of climate, gales, fires, clearances made for the extermination of wolves or robbers, fellings for house fuel or for smelting iron. In this district where, until the introduction of sheep, there were no dwellings except summer shielings, and where no traces of smelting have been found nearer than the north end of Loch Treig, the first cause seems the most likely. It may have been assisted by gales and insect and fungus pests. The trees, judging from the stumps and the few stems we have found, were short, irregular, and of very slow growth. They were disposed in scattered groups, like those which survive near Tyndrum and beside Loch Tulla or in the Wood of Cranach through which the West Highland Railway passes. Sometimes the roots are on the present surface—sometimes 3 or 4 ft. below it. Often the trees have grown on fairly deep beds of peat. The largest roots are found where the burns have at intervals of time overlaid the peat with sand. In such places there are sometimes two or even three layers of roots. The largest stem we found was above the road near the quarry (IV). It is described in Appendix I. Sections have been sent to the Forestry Museum in Edinburgh University and to the Lochaber Museum at Fort William. A stem found in Glen Spean during the construction of the Hydro Electric Works, and now in the latter Museum, is believed to bear the marks of beavers' teeth.

Native Trees.—The only trees surviving here in 1891 were birch (*B. pubescens*), rowan, black alder, aspen, birdcherry, and certain willows. The birches are for the most part distorted by snow, and some have assumed very curious and picturesque shapes. *Salix reticulata* and *Betula nana* occur pretty frequently, and occasionally juniper. On Loch Treig side a few stunted ashes and hollies survive. After the great gale of January 28, 1927, Mr. Duncan Robertson picked up a fresh, well-grown holly leaf in Coire Bhreac Beg. It had probably been blown up from the head of Loch Leven, about 12 miles, over a 2000 ft. ridge.

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NOTES ON PLANTED TREES

SCOTS PINE (*Pinus silvestris*).—The earlier planting was done chiefly with this species, not unnaturally, since the moss is full of its roots, but we have had to give it up. It is not under present conditions suited to the locality, though it thrives at Fersit, only 8 miles away as the crow flies, but 500 ft. lower in elevation. It is easy to establish, and, with the possible exception of the mountain pine, provides the best advance crop for killing out the heather and creating shelter. It suffers from all kinds of scourges—sawfly caterpillars, weevil, beetle, aphid, leaf shedding, canker, witch's broom, etc., but, provided the ground is not waterlogged, survives them all. More serious is the snow damage, which breaks down even large trees, and the browning of the foliage by the spring winds, which in unfavourable years kills the trees wholesale on exposed areas even after they have reached a height of 15 to 20 ft. These winds are particularly destructive when the ground is frozen and the roots are unable to replace the moisture of which the leaves are robbed. Close canopy is no safeguard. Quite the reverse. In this cold and wet climate light and air are essential. The trees on the islands and promontaries have always retained a good colour and suffered less than those in the woods. Where the pine escapes these dangers, the growth at its best is that of Quality Class III.¹ The leaves are always small and are seldom retained more than two years.

It is a pity that no record has been kept of the origin of the seed from which the plants were raised. The planting was done partly by John Boyd, the forester at Pollok, and partly by contract. Boyd had strong views about seed, and would not willingly have used any except from Strathspey. Howden, of Inverness—one of the contractors—used to gather his seed in the Brodie woods. It is therefore probable that most of the trees are of native origin. About an acre (III) was planted in 1911 with seedlings raised from cones gathered in the old

¹ Forestry Commission: Bulletin No. 3, 1920.

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Cranachan Wood and the wood on Loch Tulla. These trees have grown slowly, and seem rather narrower in habit than the others and shorter in the leaves. They are unfortunately not on typical pine ground, and, though 17 years old, have scarcely reached the stage when snow proves most destructive. The best are 16 ft. high. They look feeble compared with their neighbours from Strathspey.

There was no local nursery when the planting began, and the plants imported from lowland nurseries were very slow in establishing themselves. Black game helped to keep them back, as many as 400 buds being on one occasion counted in the crop of a single black cock. Once established, the trees made a fairly regular growth wherever the ground was not waterlogged. The following figures, taken from a tree near the loch-side in Compartment XVIa, immediately to the west of the Wild Cat Burn, are fairly typical:

YEAR.					Height growth in inches.
1920,	...	...	...	...	12
1919,	...	...	...	...	13
1918,	...	...	...	...	15
1917,	...	...	...	...	16½
1916,	...	...	...	...	17
1915,	...	...	...	...	16
1914,	...	...	...	...	14
1913,	...	...	...	...	13
1912,	...	...	...	...	15
1911,	...	...	...	...	13
1910,	...	...	...	...	11
1909,	...	...	...	...	10
1908,	...	...	...	...	7
1907,	...	...	...	...	7
1906,	...	...	...	...	4
1905,	...	...	...	...	4
1904,	...	...	...	...	4½
1897-1903,	...	...	...	...	7½

Total height growth in 24 years, 16 ft. 9 in.

Average annual growth, 1897-1906, ... 2'0 in.

Average annual growth, 1907-1920, ... 12'7 in.

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The dominant trees in this group were in 1926 at the age of 30, about 25 ft. high, with a girth of 15 in. to 18 in.

The turf-planted pine, though mostly on unsuitable molinia ground where the pine never gets a secure footing, has a better height growth in the earlier years.

The earliest plantations (III, IV, and V) are now 33 years old. The largest pines are 30-35 ft. high, with girth of 20-30 in., but very few have reached this size. The higher plantations on both sides of the loch were killed wholesale in 1922, 1923, and 1924, when three exceptionally cold summers were followed by wet and open winters. The lower plantations were also badly hit, the crowns becoming so short and thin that the height growth was severely checked. Even after the good summers of 1925 and 1926, many are still hanging between life and death. Earlier and heavier thinnings might have rendered these woods more resistant. The isolated trees on exposed sites have suffered far less than the crowded, especially where they have been pruned. It is not always realized how well the pine responds to a light pruning.

Dr. Augustine Henry has recommended a trial of a well-marked type of *P. silvestris* from the Engadine valley. This tree, mixed with larch and spruce, produces good timber at 5000 ft. near Zernetz. Dr. Henry kindly sent us seed to be sown in 1927. We are also trying some seed brought here by Mr. Caverhill in 1926 from trees growing in latitude 67 at 1300 ft. elevation in Finland. Neither of these lots look very promising in the nursery.

The timber grown here on peat is soft and brittle in spite of its slow growth. It is greatly inferior to that grown equally slowly on gravel at the same altitude in Strath Don. The poor quality of the Scots pine on the cutaway bogs in Ireland has been attributed to its rapid growth, but the nature of the soil probably has a good deal to do with it.

CORSICAN AND AUSTRIAN PINES (*P. laricio*).—Some hundreds of both these species were included in the earlier

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plantations. They grew quite well for a few years, but have now nearly all disappeared. For the most part they died off quite suddenly. They probably require a warmer summer.

MOUNTAIN PINE (*P. montana uncinata gallica*).—This upright form, which the French call pin-à-crochets, is only found in the Briançonnais and the Pyrenees, districts where the spruce is not indigenous. Elsewhere the tree seems to have been ousted by the spruce, and survives only in its dwarf form in the inclement zone above the spruce level. In the upright form, as seen near Mont Louis, Pyrenées Orientales, it is a fine tree with clean boles of 30 to 40 ft., at elevations too high for beech or silver fir. It grows less rapidly than Scots pine, but resists snow far better. The timber is considered better than that of the local Scots pine. That used by Vauban in the barracks at Mont Louis is still sound.

We obtained our first consignment of seed from the Sécherie de Mont Louis in 1906, and over 30,000 plants were put out on turfs in 1908 and the two succeeding years. Unfortunately the greater part was used in beating up Scots pine, for which purpose no species could be less suitable.

A plantation west of the Offices (XIX), made in 1908 on swampy ground, has suffered a good deal from leaf shedding and Brunchorstia. The tallest trees in 1929 averaged 14 ft. to 16 ft., with a girth of about 12 in. Another plantation near the Coire Creagach gate (XX), made in 1910 on the worst type of peat, is healthy, though slow in closing up. It was kept back by black game. The best trees are in 1928, 10 to 12 ft. high, and beginning to kill out the heather.

So far the tree has scarcely had a fair trial here. A group on rather better ground at the top of Compartment XI, planted in 1915, might be extended. It appears to like a dry climate and light soil, and would possibly do better in the east of Scotland. Mr. J. Burt Davy reports a variety from swampy ground in the Jura, which sounds

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more promising. It is, however, doubtful whether there is really any place for this tree in British forestry, except as a wind break, and possibly as a nurse for spruce. It has been so used here in Compartment V.

The dwarf form (*P. montana pumilio*) is less particular as to soil and less subject to leaf shedding and Brunchorstia. It has here proved the hardiest and most accommodating of all conifers. It makes an amazing root growth in peat. A plant 2 ft. 7 in. high, pulled up six years after planting, had roots up to 7 ft. 9 in. in length. It forms a good advance crop, in that it kills out the heather; but it wants watching, being apt to overlay the species it is supposed to nurse. It is also very troublesome to remove when it has once formed a thicket. Spruce planted in a matrix of this pine grow well. Experiments will be found in XII and XVIa.

An intermediate form from Central Europe (*P. montana uncinata*) is to be avoided. It lacks the merits of the other forms, and is more susceptible to disease. It is difficult enough to keep the upright and dwarf forms separate in the nursery, as they are indistinguishable for the first two or three years, and the introduction of a third simply confounds confusion.

SWISS STONE PINE (*Pinus cembra*).—For 20 years this seemed our most trustworthy tree, not for timber—it is too slow—but for shelter and ornament, and every year we planted more of it. In 1920 it began to be attacked by a fungus which Dr. Malcolm Wilson identified as *Brunchorstia destruens*. This had first been observed on some mountain pine in a dank hollow near the boat house on plants imported from Denmark. It spread with extraordinary rapidity on the Cembran pine, and by the end of 1922 had attacked even isolated specimens at the far end of Leitir Dhubh. A succession of cold summers and open winters no doubt favoured it. The warm summer of 1925 seemed to check it. The worst trees were cut and burnt that autumn, and others carefully pruned in the groups near the Lodge. But the disease

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is still active, and it seems doubtful whether any trees will survive. Until this attack, the tree grew here as rapidly as it grows in a lowland garden. The idea of making further plantations has been abandoned, and the nursery stock burnt.

The first Cembran pine planted here about 1892 in Leitir Dhubh (Ia), beside the Old Lodge path, measured in October, 1929, 32 ft. by 28 in. The tallest survivors of the 1903 planting near the Lodge at the same date were 20 ft. to 25 ft. high, with a girth of about 1 ft. 6 in. All have been checked by the disease.

WHITE PINES (*Pinus strobus* and *P. monticola*).—The conditions are too severe for *P. Strobus*, the eastern form, which gets killed back by frost, though surviving in a mutilated condition. *P. monticola*, the western form, grows well provided it is on good soil. It is a failure on peat. Fear of the rust deters us from planting it in quantity, but if the groups at the Lap Burn (XII) and Coire Creagach Burn (XX) prosper, it should be tried on a bolder scale.

MACEDONIAN PINE (*Pinus peuke*).—This Balkan five-needed pine has only been tried in two small groups—one near the pinetum (XVI) and another near the upper gate of the Lap Burn enclosure (XII). It does not grow so rapidly as *P. monticola*, but appears to be less exacting as regards soil. It has not so far been attacked either by white pine rust or Brunchorstia.

JACK PINE (*Pinus Banksiana*).—This has only been tried on bad ground near the Boat House (V). Planted out on turfs in 1910, the best after 19 years' growth are 15 ft. by 9 in., with stems like fishing rods, but brittle, and very liable to snow damage.

LODGEPOLE PINE (*Pinus contorta* or *Murrayana*).—The first variety we had under this name, with heavy glossy foliage, is of no use because it will not stand up. Latterly we have obtained another, which seems more likely to

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keep its feet (XXI). This appears to be the plant usually called *P. contorta*. It has made a remarkable root growth in scirpus peat, and may prove useful in reclaiming soil of this type. It has been tried on a larger scale this year in XVIIIc.

EUROPEAN LARCH (*Larix decidua*).—This tree grew at first faster than any other wherever the ground was at all suitable, but there is no real larch ground here except along some of the burns and on the steeper parts of Leitir Dhubh. On such ground the growth is that of Quality Class II.² The larch appears to be very much at the mercy of the seasons here. From 1907 to 1916 it was the picture of health. In winter the stems and twigs were clean and brilliant. In 1917 it was badly attacked by chermes, and canker followed. The cold summers and open winters of 1921 to 1924 were very hard on the larch everywhere in this district. The plantations here were never free from chermes during that period, and canker was active both on stem and branches. A great many twigs died back, and in 1928 the trees still look black and miserable, though heavy thinnings and two good summers have done something to revive the foliage.

The largest of the older groups was planted in 1904 on a mass of boulders and soil brought down by the Coire Creagach burn (XIX). Here the best trees in October, 1929, measured 40 ft. by 20 in. Groups a few years older will be found in Compartment XVI, but mostly on unsuitable ground. A few good trees will be found on exposed ridges in VI and VII. Larger plantations on moraine heaps were made in 1907 in Compartments XXI and XXII. These still look well. Other attempts to establish larch plantations have been a complete failure, notably one in 1908 on the west side of the Lap Burn (XI) and groups in the new Meall Glasuaine ground, planted on rather doubtful soil during the bad seasons mentioned above. The origin of the seed may have something to do with success or failure. Unfortunately,

² Forestry Commission: Bulletin No. 3, 1920.

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the only plants of known origin are some raised from seeds gathered at Fersit (900 ft.), and planted in 1925 beside the Wild Cat Burn (XVIIIc and XVIIIId).

It would appear useless to plant this tree here except on open stony soil with perfect drainage. Even so, on this side of the watershed it will not grow at high elevations as it does in Mar or Atholl. It will always lead a precarious existence, being at the mercy of its insect and fungus enemies when a succession of bad seasons gives them the upper hand. Comparing the larches here with those growing in the forest of Caenlochan in Forfarshire at an altitude of over 1500 ft., one sees a great difference. The Caenlochan wood, now over 100 years old, with its gnarled trunks and open glades, is like an alpine forest near the snow line. The trees are poor enough in form, but the timber is said to be everlasting, and their short, massive grey stems and amber twigs bear every evidence of perfect health. Our lanky, black-stemmed trees here have grown faster for their age, and are straighter, but do not look nearly so much at home nor so likely to attain a healthy old age.

Seed was gathered here for the first time in February, 1927. The few plants raised shewed great vigour in the Pollok nursery, and averaged over 3 ft. when planted out in November, 1929. See XVIIIe.

JAPANESE LARCH (*Larix leptolepis*) is much more accommodating than the European as regards soil, and its general health is less affected by bad seasons. It has one serious drawback, in that it fails two years out of three to ripen its leader. Frequent pruning of the tops is therefore required to keep the tree straight. Given such pruning, it grows well.

The oldest trees here are below the road behind the Lodge (XVII). They were planted in 1905 on gravel excavated from the road, and regularly pruned so long as the tops were within reach. The best tree in October, 1929, measured 44 ft. by 28 in. It is isolated from the rest, which proves that the others would have been the better of earlier and more drastic thinnings.

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In Compartment XXII an acre or so of fairly good ground was planted with this species in 1907. Unfortunately, the tops have not been regularly pruned, though gone over from time to time. The plantation was pruned and thinned in 1925 and again early in 1927, but is still, in 1928, very irregular, though healthy.

HYBRID LARCH (*Larix leptolepis* x *Larix europea*).—The earliest supposed hybrids are beside the bridge on the Ruidh Burn (XII)—bought plants of unknown origin and variable type, planted in 1916.

In the Birch Wood enclosure (IA) there is a larger group, planted October, 1925. The eastern twelve are from seed gathered at Dunkeld from trees of the second generation. The rest are from trees of the first generation in the garden at Keir. The Keir trees were raised at Dunkeld.

Two larger batches were planted out in 1926 and 1927. One was raised at Pollok from seed given us by the Duke of Atholl. The other was bought from Messrs. Smith & Meldrum, who probably got the seed from Glamis. The former has been planted at the top of the Clach Mhor (Ic) and the latter on the stony ridge in the new Meall Glasuaine ground (XVIII^d and XVIII^es). It is too soon to say what this tree will do here, but, judging from its growth elsewhere, it might be expected to do better than either of its parents.

WESTERN LARCH (*L. occidentalis*).—This tree, the finest of its race, appears to be quite as susceptible to climate here as the European larch, and does not grow with the same vigour. The one good point about the tree used to be that it escaped chermes. It seems to have lost even this virtue.

Four specimens given us by Mr. H. J. Elwes were planted in the Lap Burn enclosure (XII) in 1908. These were from Idaho seed. One died, two were attacked by canker, the fourth grew fairly vigorously at first. It measured in October, 1926, 25 ft. by 10½ in., but it had made little or no growth for the last three or four years, and is now dead. Near these

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a larger group, from Montana seed obtained by Dr. Henry and sown at Pollok in 1909, was planted in 1913 and 1915. These trees have never looked very robust, but in 1929 most of them still appear healthy. The tallest measures 20 ft. by 8 in.

Another group from the same Montana seed was planted in the Birch Wood enclosure (IA) in 1913. Tallest in 1927 was over 20 ft., and so far healthy.

There are few favourable reports of this larch in Scotland, except from favoured spots on the east coast, though Dr. Henry's seed was widely distributed.³ The best trees known to the writer are in a large group at Gordon Castle and a small group on a steep bank facing west in the Moraine plantation at Persit. Some of the latter now measure 30 ft. by 15 in., with short branches and an almost perfect form factor. They were planted in 1912. This year, for the first time, they have been attacked by chermes—very badly—and the vigour of the tops seems to be checked. They have been severely thinned and now stand about 8 ft. apart. A group at Ardehullary, which had grown to the height of 25 ft. with beautiful form and great vigour, was practically wiped out by the frosts of May 15 and 16, 1926.

A cross between this and the Japanese larch would be desirable. Captain Stewart of Shambellie sent us a seedling which he thinks may possibly have this origin. It is planted in the Birch Wood enclosure (IA). The seed was taken from a Japanese larch growing close to a western larch.

NORWAY SPRUCE (*Picea exulsa*). — This is one of the safest trees for this place. It is difficult to establish,⁴ but even after fifteen years of check it will develop into a good tree. The check period can be reduced, though in open ground not altogether avoided, by the use of acclimatized plants, careful planting, regular cleaning especially on *molinia*

³ See Dr. Henry's article, *Quarterly Journal of Forestry*, 1922, page 161.

⁴ For the reasons, see Mr. Robinson's statement, quoted on page 50.

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or heather ground, and the use of basic slag, to which the tree readily responds. It had not really a fair trial here till 1908, when we began to use it for turf planting. A few trees near the Boat House (V), which escaped after long suppression by heather and Scots pine, are now, thirty-four years after planting, 25 to 30 ft. in height and growing well. A small group in the Meall Glasuaine Plantation (XVIA, *q.v.*), which grew well from the start, contains at 28 years of age trees from 25 to 30 ft. This indicates Quality Class IV.⁵ Judging by measurements recently made at Moorburnhead, it seems probable that where the initial difficulties are great, the second crop and even the first in its later stages may reach a higher quality class. On this poor soil, where dense canopy leads to sudden and premature suppression of side branches and consequent decline in height growth, it does not seem necessary to plant nearer than 4 ft. 6 in. Otherwise, very early thinnings must be made. The slopes above the quarry flat (V) promise to produce the tallest trees here. They were planted on turfs in 1910 and 1911, when the Scots pine already provided shelter and the heather had been killed out. Others were added two or three years later, where the ground had been prepared by an advance crop of mountain pine. Even here the growth shews no sign of exceeding Quality Class III. Turf-planted, this tree transplants fairly well, but not nearly so well as Sitka spruce.

SITKA SPRUCE (*Picea sitchensis*).—Of all the trees we have tried, this promises the best return. It is less subject to frost here than at lower elevations, as it seldom makes a second growth. In 1926, here as elsewhere, the autumn frosts destroyed a good many tops, including in some cases the wood of the previous year. But this was quite exceptional. This tree is remarkably wind-fast. It grows faster than the Norway spruce, and is less intolerant of heather. Where the two species have been accidentally mixed on bad

⁵ Forestry Commission: Bulletin No. 3, 1920.

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ground, it always leaves the Norway behind. Taken all round, its growth surpasses that of any other species with the possible exception of Douglas fir, and since it greatly outnumbers this and never succumbs to wind or snow, there can be little doubt that ten years hence it will dominate these plantations unless some unforeseen catastrophe occurs. The timber, even when grown on deep peat, appears to be much harder and tougher than that of Norway spruce. The half-ripened leaders of the Sitka are occasionally blown out, and double tops may result. This and its intolerance of shade appear to be the only points in which it is definitely inferior to the Norway spruce. One merit peculiar to the Sitka which has proved important here is the ease with which it can be transplanted when grown on turfs (*see* pages 52-56).

We are beginning to find marked differences in frost resistance between various batches of Sitka. The best plants we have ever had were raised from Alaska seed, distributed by the Arnold Arboretum. They are planted out at the east end of the Clach Mhor Plantation (Ib). Two lots raised at Pollok in successive years from seed of unknown origin were lined out here in 1925 as 2 yr. 1 yr. plants and 2 yr. seedlings respectively. The older plants have been twice badly frosted. The younger, lined out beside them and now double the size, have scarcely been touched. We have in recent years only used seed from Queen Charlotte Islands.

The tallest of three or four specimens planted in the Birch Wood enclosure (Ia) in 1891 is now, at the age of 37 years, 55 ft. high, with a girth of 45 in., and still growing fast in an exposed position. Another beside it, confined by other trees, measures 50 ft. by 34 in. The latter probably gives a fair indication of the growth to be expected here on good soil under forest conditions. The tallest of a group on deep peat behind the Lodge (XVII), planted in 1909, are, at the age of twenty, 35 to 40 ft. high, and girth up to 24 in. Groups planted in 1911, between which the road passes (III and IV), contain trees over 30 ft. high 18 years after planting. No British Yield

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Tables for Sitka spruce have yet been published, but the growth here even on peat of moderate quality exceeds that of Norway spruce Quality Class I. This indicates a very large volume per acre at 70 years. The tree thus opens up an entirely new prospect for the Highland forester. Despite all these merits, one still hesitates to back this species too heavily against the Norway spruce, with its persistent growth and wonderful immunity from disease, though at the moment the Sitka certainly looks like winning.⁶

The turf planting (V, XIX, XII, IX) and mound planting (XVIII_A, XVIII_B) are uneven in growth, but promise to make good woods in the end. There have been occasional attacks of leaf shedding, but these have been confined to small areas. Otherwise the tree has so far proved quite healthy. Even after persistent check, it responds readily to a top dressing of basic slag.

SERVIAN SPRUCE (*Picea omorika*).—This spruce is very accommodating as regards soil, thriving better than any other on dry gravel at Kew and seeming equally at home here on good black peat. It has only been tried in two small groups (XII_A) on the Ruidh Burn and near the Lap Burn, both planted in 1908. The height growth is about equal to that of Norway spruce, the tallest in the latter group 20 years after planting being 20 ft. 6 in. by 17 in. At Fersit, 500 feet lower than this, some trees growing in a rather dense group near the railway, on peat quite 6 ft. deep, are 25 feet high and the picture of health. The habit is slender, and it makes less wood than the Norway spruce in proportion to height. If it be true that the Venetians preferred the Servian spruce for masts when they ruled the Mediterranean, it should provide valuable spars. It has so far been perfectly healthy and quite hardy. Double tops have occasionally to be removed. Seed was unprocureable during the war, but this year a few hundred plants were put out beside the loch in Compartment X.

⁶ Since the above was written the Forestry Commission has published a Table of Age-Height Curves for Sitka spruce. Bulletin No. 10, 1928. The growth at Loch Ossian seems at best to lie in Quality Class III.

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WHITE SPRUCE (*Picea alba*).—This tree has been so strongly recommended by continental foresters for bad soils that we tried it here with a good deal of confidence, and on a fairly large scale. It has proved decidedly inferior to the three spruces described above. The tree has a very wide range in North America. The seed current in Europe is probably of eastern origin. A more westerly type might succeed better in this humid climate.

The best groups are in Compartments XII and XVI_A. The former, between the path and the loch to the west of the Ruidh Burn, was planted in or about 1911. The largest tree in October, 1929, measured 23 ft. by 19 in. Other specimens will be found in the same compartment in the 1909 turf planting near the Lap Burn. Here they were mixed by mistake with Sitka, so it is possible to compare the growth. On the better ground the Sitka has walked away from the white spruce. On the worst there is not much to choose between them. A hybrid between these two species has occurred in Denmark, where it is considered a useful tree.

The turf planting in Compartment XVI_A, above the pinetum, on molinia ground, has done fairly well. It dates from 1909. The best trees averaged in October, 1928, about 17 ft. high, but others were not more than half that height. For plantations on very poor peat, see XIII and the quarry flat in Compartment V.

On the whole, it would appear that the white spruce has no place here, being no more hardy than the Sitka or Norway spruces, and inferior to both as a timber tree. Resistance to wind seems its chief merit. At Ashgill, in the valley of the South Tyne, it was planted on a large scale between 1250 and 2000 ft. Mr. A. C. Forbes⁷ records that at the top of this wood it stood up to the gale where Norway spruce and beech could not shew their heads above the enclosing wall. He and Mr. J. F. Annand both think that the timber cut at the age of 50 to 55 was more subject to heart rot than the common spruce. A timber merchant who felled white

⁷ Armstrong College, Newcastle. *Forestry Work*, 1904-6.

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spruce at Ashgill during the war assured the writer that he had no complaint to make on that score, but his staff may not have distinguished the species. The timber merchant working at Pitfour, Mr. Bisset, found the white spruce inferior to Norway both in size and quality.

ENGELMANN SPRUCE (*Picea Engelmanni*) is very hardy, and resists snow well, but it is no better in these respects than Norway, while its growth is much slower. The group in XVIIIc consists of plants brought from Germany before the war. This tree might make a useful permanent screen at the top of a high plantation.

SILVER FIR (*Abies pectinata*).—By the time these plantations were begun, this noble tree had been practically ruled out by Scots foresters on account of the ravages of the chermes. In this isolated place there might have been a chance of escaping this pest if we had grown all our plants from seed and allowed none to be imported. Unfortunately, this chance was missed. A few plants were bought in as early as 1892 and planted as specimens in the Birch Wood, but none survives. A group planted in the Black Wood enclosure (1A) in 1913 became infested with chermes, and had nearly all to be burnt.

A larger colony of small plants, 9 in. to 12 in., used to under-plant the Scots pine on the steep face above the road west of the quarry (IV), has fared better so far. It was planted in 1917.

A few hundred plants raised at Pollok were planted out in Compartment XI in 1926 under the Scots pine beside the path.

NOBILIS FIR (*Abies nobilis*).—The beauty of this tree seems to have blinded its admirers to its value for timber. The wood is by all accounts stronger and more durable than that of the common silver fir or Norway spruce. It is a tree for the bosom of the forest. In some districts the stem has a tendency to split. Sun and frost are both accused of causing the fissures, which often reach the heart of the tree. They do not injure the growth, and

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the bark in time covers them; but they never heal, and on the saw bench the result is deplorable. The writer has seen these fissures in Norfolk, Forfarshire, and Lanarkshire, but rarely in the West Highlands. Here, with its love of moisture and tolerance of peat, this tree seems quite at home. Its sturdy growth and elastic branches specially equip it for high elevations, and no tree stands up better to the snow. In wind firmness it is only second to the Sitka spruce. Blizzards sometimes brown the leaves in exposed places, but no trees have been killed here. Until 1923, when *Rhemiellopsis bohemica* appeared, we regarded the tree as immune from disease. This beastly fungus attacks the young growth, which it may completely destroy. We have found it difficult to eradicate (*see* 1A), but so far it has not spread beyond the group first attacked. Like most fibrous-rooted trees, the *Nobilis* fir grows well on good black peat. It appears somewhat intolerant of lime. Trees lined out in garden ground lined the previous year turn yellow. It responds however to a top dressing of basic slag almost as freely as the spruces.

The oldest *Nobilis* firs here are in the Birch Wood (1A), planted 1892. The largest—a rough one—in October 1928, measured 56 ft. by 57 in.—not a bad growth for 36 years above the 1300 ft. contour. Other specimens in the Birch Wood are 40 ft. and over.

Trees almost as old near the Boat House (Compartment III and IV) were outgrown by the Scots pine, and suppressed for nearly 20 years. They were not more than 3 to 4 ft. high when Cameron gave them head room, but they have since made a good annual growth, and are rapidly leaving the pine behind.

Beside the Lap Burn (XIIA) there is a group, planted in 1909 on peat 3 to 4 ft. deep. The tallest of these in October, 1929, measured 32 ft. by 20 in.

Further experiments on deep peat have been made on a *molinia* flat behind the Boat House (III) and near the Quarry (IV).

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Other groups of various dates will be found in Compartments XVI, XVII, and XI, and larger plantations in IV, V, VII, XVIIIa, and Ia. In the latter, the tree will be found mixed with Sitka.

GRANDIS FIR (*Abies grandis*).—This tree grows well here, given a decent soil and reasonable shelter. It occasionally gets cut by frost, but no established plants have been killed. It hates wind, being, like the *Nobilis*, a tree for the bosom of the forest.

In 1914, 550 *grandis* were inserted in a six-year-old plantation of dwarf Mountain pine on alluvial soil near the Lap Burn (XII). The dominant trees in October, 1929, averaged 30 to 35 ft. by 17 in. A plantation a little higher up the burn was a complete failure. This was on a peaty soil over granulite, but oriental spruce is now doing pretty well on it.

A small group on the horse-shoe bank across the Lap Burn (XI) has suffered from wind and broken tops.

A group in the Birch Wood enclosure (Ia) is doing fairly well. This was planted in 1913.

One or two specimens in the Birch Wood planted in 1892 have got above the birches, and look rather unhappy. The tallest in October, 1926, measured 45 ft.

AMABILIS FIR (*Abies amabilis*). — This tree has not yet had a fair trial in this country. Most of the earlier consignments of seed turned out to be *Abies grandis*. All the plants we have bought under this name, except those from Dawyck, have proved to be *Ab. magnifica*. James Kay collected two sacks of *amabilis* cones for John Boyd in British Columbia in 1919, but hearing of his death, threw them away to reduce his baggage. In 1926 we bought five grafted plants from a Kent nursery. The stock is reported to be Douglas fir.⁸ They do not look much like making leaders. Since the above was written, $\frac{1}{2}$ lb. of seed has been received from the Manning Seed Company, Roy, Washington, U.S.A., and has germinated well.

⁸ Dr. Borthwick confirms the possibility of this graft.

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It is rash to judge the growth of any tree from half a dozen specimens, but, so judged, this fir does seem to do particularly well here. The specimens are in the pinetum (XIIIa). They came from Mr. F. R. S. Balfour's nursery at Dawyck, and were planted in 1917. The best is now 18 ft. high. The soil here is a poor and closely-packed glacial drift over granulite. On this soil they show a better growth than any of their neighbours, except the *Nobilis* fir, and, though much exposed, stood quite firm in the gale of January 28, 1927.

DOUGLAS FIR (*Pseudotsuga Douglasii*) had an unlucky start here. When the first trial of exotics was made in the Black Wood in 1892, the few Oregon Douglas which were included got bad places and made a poor show. The first planting at the Boat House, 1893-4, contained some groups of Douglas, but they must have been small plants, as they were suppressed for many years by the heather and Scots pine. Some of the Colorado variety planted at the same time on good soil at the west end of Compartment IV. were desperately slow in growth—the tallest after 18 years measuring 11 ft. 3 in. These facts taken together led us to believe that Douglas would not thrive here. Had a single plant of the Oregon type been included in the group in the Birch Wood, which formed the nucleus of the present enclosure (Ia), it would no doubt have kept pace with the Sitka and *Nobilis*, and we might have arrived at precisely the opposite conclusion. In that case, the Douglas would have been as freely employed as these other species from 1907 onwards, and we should have known by this time a great deal we have still to learn, especially the effect of snow and wind in the thicket stage.

On reasonably good soil—including *molinia* peat—the green Douglas seems to grow here faster than any other tree, and is much easier to establish than the common spruce. There is some loss of leaders through frost, but not more than elsewhere. The gale of January 28, 1927, shewed that on *molinia* ground the top is in the thicket

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stage out of all proportion to the root anchorage. Douglas should not be planted on such ground, even in mixture with Sitka.

The best of the survivors from the 1893-4 planting near the Boat House (V) measured in October, 1929, 35 ft. by 20 in. These trees must have remained almost stationary in height for about 20 years after planting.

No more were tried till 1908, when a few were planted by the Ruidh Burn (XII). One of the tallest of these measured in October, 1929, over 30 ft. by 20 in. This is a draughty place, and there have been a good many broken tops. Since this plantation established the fact that the tree will grow here, it has been tried on a larger scale in Compartments XVI and Ib.

At the mouth of the Lap Burn (XII) and in the Clach Mhor (Ib), we tried mixing Sitka with the Douglas in various proportions to stiffen it up. In one of the older plantations at Balmoral, where heavy snowfalls occur, this mixture has succeeded well. Unfortunately, the Clach Mhor is too much exposed, and most of the Douglas may have to be replaced by Sitka.

The so-called Fraser River type—which seems very variable—has not done much here so far, but seems more windfirm. A good many were used in the new part of the Glasuaine plantation (XVIIIb and XVIIIc). If the seed was from the Dry Belt, this is hardly the climate for it. Other types have come here by accident. The best of them, intermediate between the Oregon and Colorado, appears to be the most suitable for this place. Unluckily, we do not know its origin.

WESTERN HEMLOCK (*Tsuga Albertiana*).—Specimens planted in the Birch Wood, 1892-5, did well, and the best in October 1926 are now over 40 ft. high, with a girth of 40 in. In 1908 the horse-shoe bank, west of the Lap Burn (XI), was planted with trees bought under this name. After years of disappointment and pruning, they turned out to be the eastern form (*T. canadensis*). Meanwhile their failure unfortunately deterred us from planting any more until 1913, when a group was added

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to the miscellaneous collection in the Birch Wood enclosure. Mr. Moon, of the New York Forestry College, Syracuse, U.S.A., and Mr. Caverhill, of the British Columbian Forest Service, who spent a few days here in 1926, agreed in recommending this tree for peat planting. Its growth here seems to bear the same proportion to that of Sitka and Douglas as in other places.

GIANT THUYA (*Thuya plicata*).—This tree seems to thrive on peat, as one would expect from its fibrous roots. Here on black soil it completely loses its green colour in winter, and assumes the same deep copper tint as the heather. It grows well, but has been more damaged by hares and deer than any other conifer. Specimens in the Birch Wood, planted about 1895, were 30 ft. high in October, 1928. A group in Compartment V, planted in 1912, but eaten by hares and cut over in 1916, came away from the base, and was in October, 1928, 15 ft. high. This group is on black peat. The tree ought to be tried here on a larger scale. It seems particularly suitable for turf planting on molinia ground. It is, unfortunately, very sensitive to frost or drought the first year after planting.

NOOTKA CYPRESS or YELLOW CEDAR (*Cupressus Nootkensis*).—This note owes its origin to the enthusiastic letters Mr. James Kay has written home about the yellow cedar, which he considers specially suitable for the Highlands. He has been felling large trees on the Fraser River (outside the dry belt), and is lost in admiration of their timber, which commands a high price for boat building and other special purposes. He reports that the tree grows best in wet flats, but at 2500 ft. elevation it is still a large tree, 75 to 130 ft. high and 25 to 75 in. in diameter. Elwes and Henry, in the *Trees of Great Britain*, bear out all these statements. Elwes remarks that the yellow cedar does not respond to good soil as well as most trees—the growth being everywhere about 1 ft. a year. That growth seems

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to be maintained here, and the tree is absolutely hardy. If any slow-growing conifers are worth consideration as timber trees in this country, this is probably the best. Mr. Kay has sent home seed (1926) which we have divided with the Forestry Commission. Unfortunately, it is a tiresome subject in the nursery, rarely germinating the first year even if sown in autumn. Part of the seed was gathered at 2500 ft., and should make an interesting experiment.

A single plant of pendulous habit by the path in Compartment XIII was planted in 1907. It came from the old Veitch nursery on Kingston Hill. It was probably a cutting, like other plants beside it which were added later. A group next the pinetum in Compartment XVI, raised at Pollok from seed gathered at Sorn Castle, Ayrshire, has not done particularly well, but it is on the stiff glacial drift which most trees hate. It would probably do better on peat. The only trees on good soil are a few in the Birch Wood enclosure (IA), planted in 1914, small plants suppressed during the war by grass and ferns, but now coming away.

BROAD-LEAVED TREES.—The field for broad-leaved trees here is very limited, and none were planted before 1908. Beech and sycamore grow well. So does oak, though the few we have planted have been impeded by the shade of other trees. More beech and sycamore would have been planted if it had not been necessary to give them special protection against hares. Since 1925-26, when the hares, for some reason hitherto undiscovered, suddenly vanished, both species have been used freely. For under-planting, given mineral soil, nothing else is so satisfactory here as beech, and nothing in the young stage adds more to the charm of the autumn and winter landscape.

The hard woods in the Lap Burn enclosure (XII) were the first planted here, and date from 1908 onwards. The largest beech I can find measures 26 ft. by 13½ in. The largest sycamore, 27 ft. 6 in. by 12 in. The oaks

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were planted as seedlings about 1910. The tallest now measure 10 ft. and over.

A number of other broad-leaved trees were tried here. Elms seem to have quite disappeared, but should have another trial. So should walnut and hazel. The lime seldom ripens its growth, and tends to assume a bush-like form. The horse chestnut grows more freely, but also shews signs of becoming stunted. The Norway maple is less robust than the sycamore, and difficult to keep straight. The contrast between this tree and the common holly illustrates the extraordinary differences in the response of trees to climate. In Norway, with its hot summer and cold winter, the maple is a noble tree. Here it is stunted. The holly, on the other hand, which thrives here, cannot be kept alive at Oslo. The common thorn grows here well enough, but rarely flowers. Several species of maple—European, American, and Asiatic—have been tried for autumn colour. Of these, *A. rubrum* and *A. circinatum* do best. The *Pyrus-Sorbus* family all seem to thrive. Of the birches, *B. utilis* appears to be the most vigorous as well as the most attractive. *B. verrucosa* seems to grow better than *B. pubescens*, though only the latter is indigenous. Forest No. 22520 seems to be a vigorous birch of the *verrucosa* type. A group was planted in 1926 on the Knobbie in the garden and another in the Clach Mhor (IB).

One tree which has surprised us is Turner's oak, var. *Austriaca*, a supposed hybrid between *Q. ilex* and *Q. pedunculata*.⁹ Here it keeps its leaves till March, and after repeated frosts remains fresh and glossy long after its brothers at Pollok are bare. Unluckily, the branches break easily under snow.

Of the poplars, *P. trichocarpa* does much the best, and so far shows no sign of canker. Those at the Lap Burn were planted some 15 years later than the black Italians beside them.

⁹ Bean: *Trees and Shrubs of Great Britain*, vol. ii., page 327.

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RHODODENDRONS.—The rhododendrons which have been tried here illustrate so well the peculiarities of the climate that a note on the subject seems worth including.

Of the Himalayan group those which do best are *R. barbatum*, *R. Thomsoni*, *R. campanulatum*, *R. niveum*, *R. campylocarpum*, *R. Roylei*, and *R. Hodgsoni*. Mr. Bean describes *R. Thomsoni* as needing a sheltered position at Kew and very liable to frost in the flowers and young growths, and *R. Hodgsoni* as not hardy, so far as he knows, near London. Neither of these has ever turned a hair here. *R. Falconeri*, which he says has been given up at Kew as hopeless, seems now to be established here, though one of the plants was killed the first year they were put out. *R. arboreum* in several forms, some brought from Cornwall and some raised at Pollok from Lochinch seed, is doing well under trees. At Kew, Mr. Bean finds *R. arb. cinnamomum* the only hardy variety. Small plants of *R. grande* have scraped through one winter without protection, but a large plant from the green house in the Glasgow Botanic Gardens succumbed to frost. So did a plant of *R. Edgeworthii* from the green house at Pollok.

The hardiness of *R. ponticum* is seldom questioned, but here it is more tender than any of the species mentioned above except the last two. It gets badly browned in the open most winters, and plants are sometimes killed outright, while the flowers are always undersized. It is far less hardy than the common azalea (*R. flavum*) or *R. caucasicum*. The *ponticum* hybrids (e.g. *R. altaclerense* or *Knightii*) have likewise proved more delicate than the *caucasicum* hybrids (e.g. *R. Nobleanum*) or the *R. catawbiense* hybrids (e.g. *R. everestianum*). *R. Vaseyi*, the only American azalea tried here, is quite hardy and flowers freely. The Ghent azaleas have not been successful.

Of the Chinese species, *R. fictolacteum*, *R. insigne*, *R. sutchuenense*, *R. calophytum*, *R. adenogynum*, *R. decorum*, *R. floribundum*, *R. oreodoxa*, *R. oreotrephes*,

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R. calimorphum, *R. dichroanthum*, *R. angyrophyllum*, *R. Faberi*, *R. cyanocarpum*, and some others are doing well. *R. discolor* and *R. auriculatum* also seem quite at home, though the first snow usually comes before their new leaves are fully unfurled. *R. galactinum*, *R. habrotrichum*, and *R. neriiflorum* are in a bad way. *R. fulvum* and *R. sperabile* are shabby. Farrer's *decorum*, which we can scarcely keep alive at Pollok, and which nearly everywhere seems difficult, has only had one winter here.

All the species and hybrids mentioned above are growing at the west end of Compartment IV, under birches and rowans between 13,000 and 14,000 ft., where they do not see the sun for two months in winter. The unbroken winter is the secret of the survival here of species which prove tender at lower altitudes outside the influence of the sea. Very striking here is the protective effect during snow storms of the drooping and curling of the leaves. No hybrids we have tried, except those derived from *R. Griffithianum* and *R. Thomsoni*, have this gift. The others suffer accordingly. Their wood also seems to be more brittle. Few of the species enumerated above have reached flowering age.

The dwarf species in the rock garden are disappointing. Possibly the climate is too wet for them or the situation too draughty. *R. ferrugineum* and *R. hirsutum* do well, but the only others which seem at home are *R. kamtschaticum*, *R. chamæcistus*, and *R. myrtilloides* (1046a Farrer). *R. intricatum* and *R. fastigiatum* have flowered well for two or three years, but many plants have died off. *R. calostrotum* (1045 Farrer) shows the same tendency. *R. moupinense* is practically dead.

DRAINAGE

The difference in the silvicultural value of various types of peat is very great. The peat in this locality may be roughly classified by the surface flora into three grades. Best: strong growth of *molinia* and better grasses, with scabious and buttercups, and strong healthy tufts of ling or bog-myrtle if present. Medium: stunted heather, butterwort, bog-asphodel. Worst: *scirpus* grass, cross-leaved heath, lichens. The first with moderate draining is suitable for any spruce and some silver firs. The second, with close draining, will grow Sitka. On the last nothing except dwarf mountain pine and *P. contorta* can make any headway without manure as well as close draining.

It is impossible to exaggerate the importance of draining on all types of peats found in the West Highlands.¹ However firm the peat feels under foot, it is safe to assume, if it is more than 6 or 8 in. deep, that it is water-logged, and that the roots of any tree inserted in it will suffer from want of air. The tight kind of peat, which is often found over glacial drift, seldom makes good soil, but its character is completely changed by draining, and it will grow trees provided there is no pan below it. As a rule, the wetter the peat is before draining, the less sour it is found to be when the superfluous water is removed. The swampy ground,

¹ This view is confirmed by a report made for the Forestry Commission on trees uprooted by the gale of 28th January, 1927, in the plantation on Loch Tulla, behind the Black Mount Lodge. Here at the age of 70 Norway spruce was found up to 80 ft. in height on 18 in. to 3 ft. of peat. Where the drainage was good, the trees stood firm: where it was insufficient, the roots had only penetrated 6 in. below the surface, and they fell.

where the peat approaches the consistency of a snipe bog, grows excellent Sitka spruce. Care must be taken not to overdrain this or any other kind of peat. Like timber, it must be dry, but not too dry. There is a real danger, as the agriculturists of the eighteenth century well knew, of destroying its fertility by over-draining.

Were it possible to remove the whole of the top spit from heather ground before planting, there is little doubt that for most trees this would be an improvement. The upper nine inches of peat seems to be particularly poisonous, especially to the spruce family, until it is broken up and exposed to the air. The success of Sitka spruce on small areas of cut-away bog here (see XXI. p. 115) and the success of all kinds of trees on such bog, as compared with high bog, in Lord de Vesci's much larger plantations at Abbeyleix in Ireland, seems to prove this. A small example here in which only the top spit was removed (see V. p. 78) shows that the second spit may promote a good growth of Sitka without a healthy colour, proving that something is deficient. That something seems to be gradually acquired by the soil when exposed to the air.

Much has been written about peat lately, but there has been little advance on the methods of reclamation followed by the farmers and foresters of a hundred or more years ago. It is a case of practice outstripping science. On the other hand, we have still to learn the best way of assessing the value of peat for forestry purposes and establishing trees on this type of soil when reclaimed, and valuable results may be expected from the scientific enquiry now proceeding at the University of Aberdeen, under Professor Borthwick's supervision.

One thing is certain, the care bestowed on keeping the principal drains open will be a decisive factor in the life of these plantations. If the peat is allowed to become water logged the trees will come down like ninepins in the first gale.

METHODS OF PLANTING

Notching.—The earlier plantations here were all notched, work being confined to the drier ground. This gave fairly good results with Scots pine and larch where the work was carefully done, but in many cases the collapse of the plants under snow ten or even twenty years later was found to be due to bad nursery work and careless planting, resulting in deformed root systems.

The notched Norway spruce suffered a long check, the only exception being a small clump in Compartment XVI (q.v.). Elsewhere it only survived where it was mixed with Scots pine. Even when the conditions are favourable and the work done with extraordinary care, notching cannot be recommended for this species.¹ On molinia ground there is great risk of the notched plants being overgrown with grass. This accounts for many of the blanks found in Highland plantations.

Some parts of the notched planting on both sides of the loch were drained later, and the Scots pine responded well to this treatment.

Pit Planting.—The field for this method here is very limited. It is only practicable where the mineral soil is near the surface and fairly open, or where the peat has been drained for several years or transformed into humus by an advanced crop. Elsewhere the pits hold water, and are simply death-traps. There is a good deal of hard ground with a thin coat of tough peat over glacial drift in Compartments XVIII and XVIII. This has not yet been touched, but the intention is to plant part of it with

¹ See Mr. R. L. Robinson's statement, quoted on page 50.

upright Mountain pine and *P. contorta* in small pits cut through to the drift. Where the slope is steep enough to let the water escape, the drift may be broken up with a pick or mattock.

For larch, which can only be planted on an open soil, small pits give the best results here, and for the few planted since the war this method has been adopted.

Turf Planting.—In 1905, Dr. Augustine Henry put us on to this method—a German invention perfected by the Belgian Forest Service for the afforestation of the *hautes fagnes*, or high moors, in the Hertogenwald, near Spa, under a scheme adopted in 1894. The land to be planted, which lay between 1950 and 2150 ft., abutted on well-established woods, the margin of the latter extending in a straight line across country for several miles. On one side of this line was a flourishing spruce wood, 40-60 ft. high, on the other a stretch of peat and heather on which several attempts at afforestation had failed, notably a plantation of Scots pine made by direct sowing in 1851, of which the remains, distorted by wind and snow, may still be seen at Noir Flohay (2060 ft.). The contrast offered a challenge which the Belgian foresters eagerly took up.²

The conditions on these *hautes fagnes*, or high moors, are almost identical with those found in many parts of Scotland. The flora, except for the absence of bog myrtle, is that of the Scots moors, and this is one of the only two places (the other being in Sweden) where the red grouse has been naturalized on the Continent. The late Comte de Flandres, after two failures, liberated 50 pairs in August, 1894. In 1901, in spite of regular shooting, the stock was reckoned at 1000 head.³

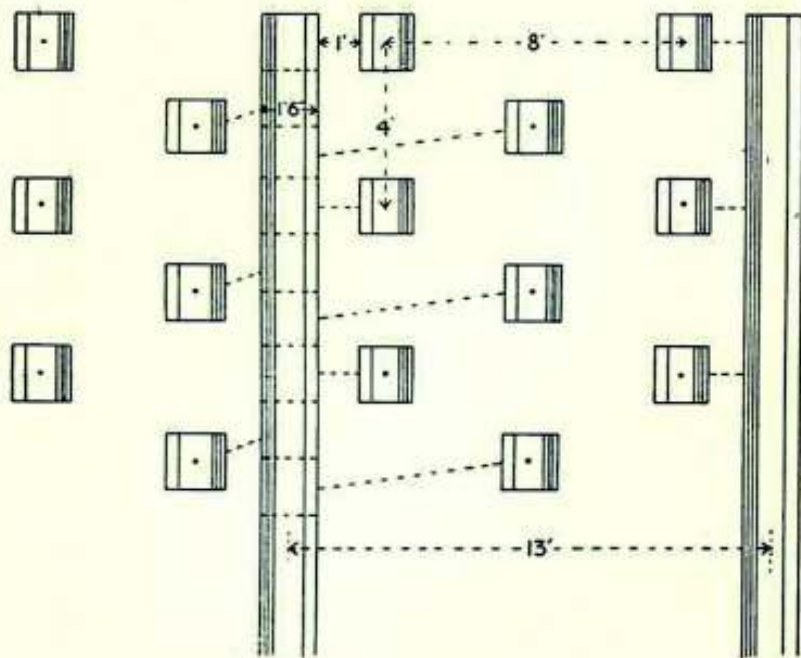
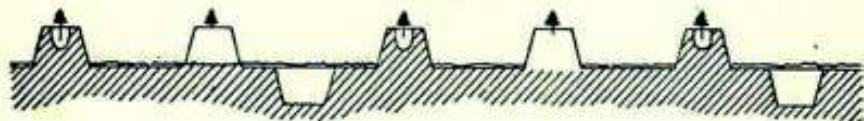
² *Bulletin de la Société Centrale Forestière de Belgique*, 1895, pages 333-370; 1896, pages 147, 215, 294; 1897, page 73; 1908, pages 1-12, 69-83.

³ *The Grouse in Health and Disease*, vol. i., page 2.

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FIGURE I.

TURF PLANTING.



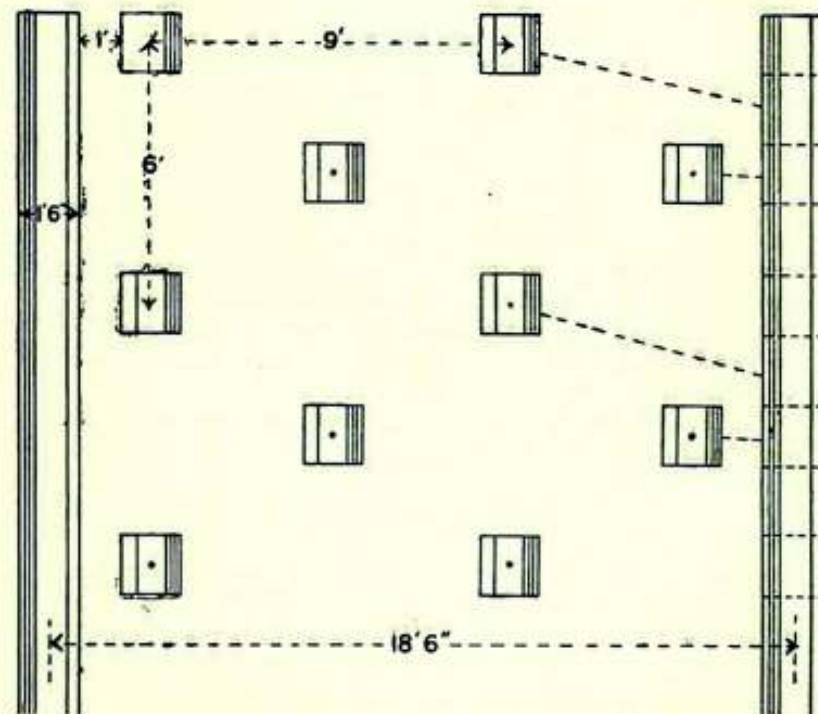
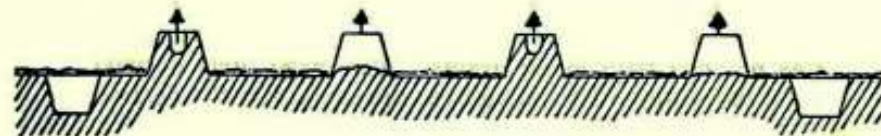
Average distance about 4 ft. 6 in. Suitable for Norway Spruce.

N.B.—The turfs are shewn 1 ft. thick, but may be reduced to 9 or 10 inches.

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FIGURE II.

TURF PLANTING.



Average distance about 5 ft. 6 in. Suitable for Sitka Spruce.

N.B.—The turfs are shewn 1 ft. thick, but may be reduced to 9 or 10 inches.

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The Belgian foresters, in the face of strong criticism,⁴ applied their planting method to these gently sloping moors in the form of a gridiron, regardless of the contours. Deep drains at right angles divided the ground into compartments of 15 to 20 acres. Each compartment was hatched with lesser drains. The large turfs derived from these were distributed over the surface at the desired planting distance, usually 2 metres by 1½ metres. On these turfs the trees were planted in holes made with a long-handled trowel. Georges Darimont, the forest guard at Jalhay, supplied us with this useful implement. Two handfuls of sand or gravel, mixed with basic slag in the proportion of seven of soil to one of slag were applied to the roots of each plant. The compost was made up wherever the nearest mineral soil was available, the slag and soil being spread in a heap in alternate layers and carried to the planting in baskets. The dose of slag works out at about 2 oz. per tree.

This method produced good results with Norway spruce in Belgium. The forest officers themselves considered the planting distance too wide, though they submitted to it from motives of economy. Recently it has been reduced. The object was to get plantations established as rapidly as possible, and this was achieved. Unfortunately, much of their work was destroyed by fire during the drought of 1911, and the best of the remainder was felled by the Germans during their occupation.⁵

⁴ *Bulletin de la Société Centrale Forestière de Belgique*, 1896, page 298.

⁵ The *hautes fagnes* were a scene of great activity in April, 1906, when the writer first saw them. Gangs of women were planting; gangs of men preparing the ground for next year's work. Young plantations were rising all round. The scheme proceeded like clock work till 1911. That year, after the fire, it was difficult to find one's bearings, but the older woods, stretching into the distance like a dark wall, were still a guide. The forest was then full of troops who had been sent up to fight the flames. In April, 1924, every land-mark had disappeared. The place was deserted. Old Georges Darimont was dead. We called on his son and successor, but he was away. The small distorted

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In applying this system to Corrou, we made some modifications. The ground is more broken than the Belgian moors, and, the areas to be drained being small, the deep cuts were omitted. The gridiron plan was abandoned, and the design made to fit the contours of the ground. The planting distance was reduced to 3 ft. or 3 ft. 6 in., with drains 12 ft. apart, and turfs 18 by 18 by 9 in. In Belgium only spruce was planted. Here we decided to use Scots pine as the main species—a great mistake, as it turned out. We had not yet realized this tree's limitations. Mountain pine was used to beat up areas where Scots pine had failed—another mistake. The spruces were thus relegated to the wet flats where nothing else could be planted. All the plants used the first two seasons were 2 yr. seedlings taken straight from the seed bed. This answered admirably with Scots pine, but the spruce seedlings were so small that careless handling resulted in their case in a heavy death-rate. 2 yr. 1 yr spruce, or 3 yr. seedlings, widely sown, are the best plants for this purpose. The upper layer of wet peat shrinks so rapidly after draining that drains 18 in. deep may in a year or two be reduced to half that depth. This led us to deepen the drains in the earlier peat planting two years after planting. We now believe

pinus at Noir Flohay were the only objects one could recognise. Yet, scattered among the wreckage, enough survives to prove that the venture would have succeeded but for fire and the Hun's axe. A few Sitka round Noir Flohay indicate that this tree would grow better than the Norway spruce.

In September, 1924, the research officers of the Forestry Commission visited the remnants of this work, and made a report which deserves to be published. To one who has known the place on and off for twenty years, and seen it at all seasons except midwinter, the report seems somewhat to underrate the extraordinary transformation in soil and flora wrought by draining, planting, and burning, as well as the climatic difficulties encountered at 2000 ft. on a moor devoid of shelter, and scarcely more than 100 miles from the North Sea. This natural understatement of the case does not diminish the value of the report for moorland planters, though it robs them of some of the encouragement they might otherwise derive from it.

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this to have been a mistake. It is enough to make sure that the main drains are functioning.

Despite such errors, this method has on the whole given good results. Its principal merits are as follows—(1) the ground, drained in autumn, can be planted the following spring; (2) small plants can be used without any necessity for weeding; (3) the tree starts life with a perfect root system; and (4) the manure ensures a good growth for the first two or three years. The turf-planted Scots pines have been badly broken by snow, but they have never been pushed down as the notched plants used to be. Judging by the earliest turf planting, it may safely be claimed that this method has in the case of Scots pine saved eight to ten years as compared with notching. The pines in Compartment XXI, turf-planted as 2 yr. seedlings in 1907, were in 1909 already well ahead of the 2 yr. 1 yr. plants notched at the same time on less peaty and carefully-drained ground alongside, while their roots were incomparably better.⁶ In 1929 the turf-plants were 15 ft. to 20 ft. high. The others, on similar soil, were scarcely 5 ft., with scanty foliage and diminishing height growth. In Compartment XVIa it is after 15 years' growth difficult to distinguish the turf-planted pines from those notched 10 years earlier. Unfortunately these pine plantings are nearly all on molinia ground and have had to be replaced by spruce.

The results obtained with spruce vary more with the soil, and are more difficult to measure, since no spruce has been notched here since turf-planting was introduced. Such evidence as there is, is all in favour of turf-planting. Much of the Norway spruce notched between 1893 and 1905 was still in the check stage in 1926. Some has completely disappeared. None of the turf-planted Norway has disappeared, and even on the worst ground it has taken a firm hold and reached the height of 3 to 4 ft. (thanks to the basic slag) before a check set in. On the better ground it has formed good plantations,

⁶ *R.S.A.S. Transactions*, 1910, page 153.

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and is far ahead of the plants notched 10 years earlier. They can be compared in XVIa. In the case of Sitka spruce, the material for comparison is more limited. Up to 1907, this tree was a rarity confined to the best ground. In the few cases where it was notched, it has undoubtedly suffered much more from frost than where turf-planted, and taken much longer to get established.

Turf-planting is obviously inapplicable where the surface peat is bad, since in that case it simply doubles the difficulty with which the plant has to contend. The turning of the turfs should be done in spring or autumn, and they should be exposed to a winter's frost and rain before planting. If turned in summer, they are apt to dry hard and not settle down properly. Turned in autumn, they shrink rapidly, especially on good ground, and in a few years are scarcely perceptible.

The cost per acre of the earlier turf-planting, at 3 ft. by 3 ft., 1907-10, worked out as follows:—

Making drains and placing 4843 turfs,	£2 15 0
4843 plants (2 yr. seedlings), ...	2 0 0
Planting, including conveyance of sand,	1 0 0
Basic slag, ...	0 5 0
Deepening drains (2 years later), ...	2 10 0
	£8 10 0

The present cost of turf-planting Norway spruce 2 yr. 1 yr. plants at 4 ft. by 4 ft. would be about £9 10s. per acre, allowing for the increase in wages, and reckoning a decrease of one-third in the amount of labour required on account of the wider planting.

For Sitka spruce at 5 ft. by 5 ft., the cost should be about 25s. less, or £8 5s. per acre, allowing for the reduced number of turfs and plants, and a slight though not proportionate reduction in the amount of draining. No provision is made for deepening the drains, as we believe this to have been a mistake.

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Mound Planting.—This is a variant of the method explained above. It has been adopted here during and since the war, partly because we lacked men accustomed to lifting heavy turfs and partly because an increase in the planting distance to 5 or 6 ft. has made more material from the drains available for each plant. The mounds are about 3 ft. across, and at first 18 in. high, but they soon sink to about half that height. The method of planting is the same as on the turfs. To save labour, we have recently applied the basic slag without sand as a top dressing after planting. This succeeds quite well, as the slag washes into the interstices of the debris composing the mound. The mounds are really better than the turfs in as much as they provide more material for the plant, and material which weathers faster than a solid turf. They are unfortunately decidedly more expensive. The plants cannot of course be transplanted so readily.

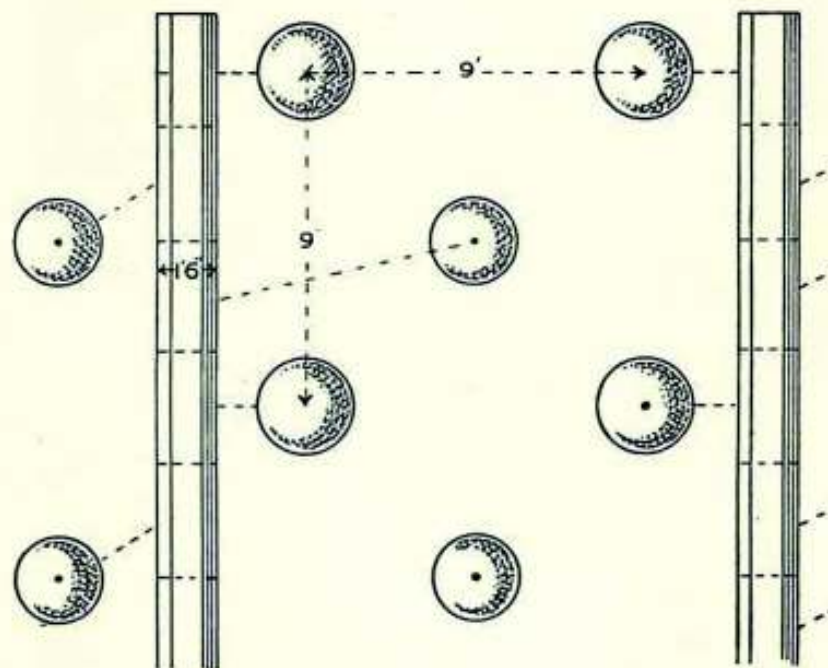
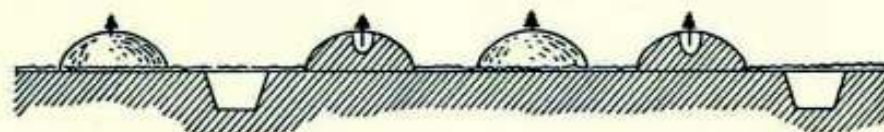
The cost of mound planting at $5\frac{1}{2}$ ft. in 1920-21 (XVIII A, B, and C) worked out at £18 10s. per acre, including plants and basic slag. The wages paid were 42s. per week. At present rates, 33s. per week, the cost would be reduced to about £14 15s.

Manteufel System.—At the north-east corner of Compartment XIX, near the point where the road divides, a dozen Scots pine were planted in the spring of 1905 on the Manteufel system. A basket of earth was placed on the natural surface. The 2 yr. seedling was dibbled into it, and two semicircular turfs were placed round it, upside down, to cover the mound. This is a clumsier version of the Belgium system, with the objection that draining does not form part of it. The plants grew remarkably well for the first three years. They then became very yellow, but in 1911 showed some improvement. The ground was drained for the first time that autumn, and the debris thrown round the plants. In 1912 they regained their normal colour and growth. They have not grown as well as the turf-planted pines on similar soil.

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FIGURE III.

MOUND PLANTING.



Average distance, 6 ft. 6 in. Suitable for Sitka Spruce.

N.B.—The drains are shown 1 ft. deep. A 3-ft. run of such a drain should provide mounds 2 ft. 6 in. across and 1 ft. 6 in. high when first constructed.

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Inchnacardoch System (Turf planting by side notch).—This method, evolved by the Research Staff of the Forestry Commission, and first tried at Inchnacardoch, is described in a memorandum written and circulated by Mr. R. L. Robinson, in December, 1926, from which the following extracts are with his permission taken:—

"Careful dissection and study of the roots of large numbers of spruces has shown that when a spruce is planted deeply (*e.g.*, by vertical notching), the lower part of the nursery root system invariably dies. This may result in the death of the plant, but more frequently it remains in a state of 'check' until it has formed a new root system. This new root system either develops from the upper remnants of the original nursery root system, or new roots are put out at the collar of the plant. The new root system is thus essentially a shallow one developing in the aerated soil or vegetation layers. It is frequently marked by long 'pioneer' roots, with here and there bunches of mycorrhiza roots in decaying vegetation, such as *molinia*. Apparently the plant feeds through the mycorrhiza rootlets. As the new root system develops, the checked plant regains its normal green colour and proceeds to grow. On poor peaty sites, spruces may remain in check for 15 to 20 years and yet ultimately come away.

"Owing to this habit of checking, the establishment of spruce plantations is often a very costly business. The first planting is cheap enough, but costs accumulate for the following reasons:—

- (a) Excessive deaths.
- (b) Beating up plants which look sickly but are merely in check. Much money is often wasted in this way. The rule should be never to beat up a spruce which is alive.
- (c) Prolonged weeding.
- (d) Check increases the length of the rotation.

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Obviously, also, a plant which remains in check has not the same power of ultimate growth as a plant which uses its youth in a more profitable manner.[†]

"From the above considerations, it appeared probable that the main problem in spruce planting (assuming the site to be otherwise suitable) was to secure adequate root aeration. If the original nursery root system could be kept alive and made to function, the check period should be reduced to a minimum.

"The Research Officers have accordingly developed a method known as the side-notch method, which has given very promising results. As with the Belgian System, the turf (which in this case should be 15 in. by 15 in. by 6 in. to 8 in. thick[‡]) is inverted, but in planting there is the essential difference that the roots of the spruce are spread out horizontally on the natural surface of the vegetation, and the turf rests on them.

"In order to get the spruce into position, the turf is slit vertically from one side to the centre with a spade, the turf is then raised up by the outside ends of the slit, which at the same time opens the slit, the plant is pushed in the slit to the centre of the turf, its roots are spread horizontally below the turf, which is then dropped back into position and firmed.

"Care should be taken to make the notch on the lee side of the turf, on the side sheltered from the sun.

"It seems reasonable to conclude that the turves should be prepared well in advance of planting, in order that the natural vegetation should be killed, and that weathering by winter frost, etc., should take place."

[†] This appears to be the generally accepted view. If it means that the sort of ground on which a prolonged check occurs will never grow first-class trees, few will differ from it. But if it means that the check impairs the vigour of the plant so that it can never attain its normal size, it does not seem to agree with our experience of Sitka spruce here. Plants checked even for ten years or more seem, when moved to good soil, to grow quite as vigorously as young plants, though it remains to be seen whether their growth will continue to the normal limit.

[‡] In practice, 4 in. to 6 in. is found easier to handle.

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An experiment with this method was made in Compartment XVIIIb in 1927, with both Sitka and Norway spruce, to compare it with the Belgian turf-planting, and to test the value of manure in both cases. See Appendix IV.

Transplanting.—The ease with which turf-planted Sitka spruce can be transplanted is quite surprising. The anchor roots have of course to be cut. Even in the case of trees 4 to 5 ft. high, these are often 10 or more ft. in length. But a ball 2 ft. across by 18 in. in depth contains enough fibre to carry on the growth of trees of this height almost without a check. The ball is composed of the remains of the original turf, together with a slice of the peat on which it rests. The plants can be carried by the stem one in each hand to their destination without any danger of the ball breaking. Even when the lifted trees have been left by mistake unplanted, they seem to have no difficulty in establishing themselves. Norway spruce does not transplant nearly so well, though turf-grown plants move better than those planted otherwise.

The unexpected mobility of the turf-planted Sitka has proved very convenient here. Turf plantations made on poor ground at 3 ft. have been thinned by the removal of half to three-quarters of the crop, and the lifted trees have been transported to better ground where other species have failed. This is admittedly robbing Peter to pay Paul. The formation of canopy on the poor ground is delayed. But in a few years these close plantations would have had to be thinned in any case, and, by moving the superfluous plants, the stocking of better ground is achieved with an expedition otherwise impossible. The smaller plants are, so far as possible, selected for this work. The pits from which they are lifted are left open to promote aeration of the soil.

Since 1921 a good deal of this transplanting work has been done in Compartments V, XVII, XIX, and XXI. Most of the transplants have been moved to sheltered

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spots and better soil. One open space of about two acres in Compartment XIX traversed by the middle ride was entirely planted in this way in the autumns of 1925 and 1926. Here the drains were first marked out, the transplants were then placed on the natural surface, after which the drains were dug, the debris being piled round the plants. The plants varied in height from 2 to 9 ft., the larger being placed under the lee of an older wood. This *tour de force* was suggested by the fact that the plants were close at hand and on the verge of requiring to be thinned. As a rule no manures have been used in this work. The growth is sometimes checked for a season, but is nearly always resumed the second year. In the case just described manure was applied two years after removal.

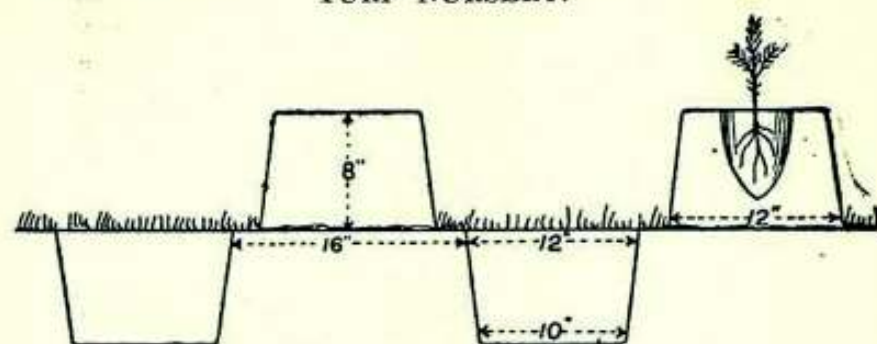
The cost is about £7 per acre where the transplants are pitted at 6 ft. Where the ground has to be drained and mounds are used the cost is more like £10. The early summer and early autumn seem to be the best seasons for this job, but it can really be done at any time, avoiding hot weather when the half-finished growth is apt to flag, and the moment when the new growth is nearly complete but still soft and brittle. Trees up to 6 ft. in height moved in early summer sometimes show no check at all, and make a full growth the following year. It remains to be seen whether this work entails any risk of heart-rot in Sitka spruce, as it undoubtedly does in Norway when large trees are moved.

Turf Nurseries.—The success of this transplanting work has led us to devise a new type of flying nurseries for Sitka spruce on high and exposed planting sites. The first batch of these was constructed in Compartment VII in the spring of 1926 for 9000 plants at an elevation of about 1500 ft. Rows of turfs were turned over (see diagram), and a plant set on each with basic slag and sand, as described on page 44. For this purpose 3 yr. seedlings from a fairly open bed seem best. Each nursery contains 1500 to 2000 plants, i.e., enough to

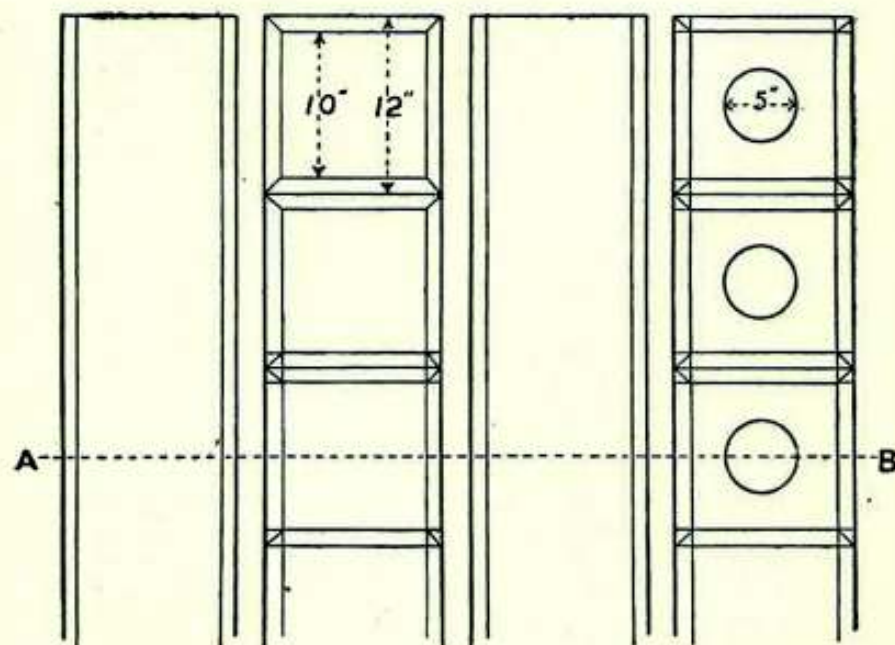
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FIGURE IV.

TURF NURSERY.



Section on Line A—B.



After the turfs are turned over, a nick is cut out between them to prevent the roots from crossing from turf to turf.

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plant an acre at 5 to 6 ft. The ideal (where the ground is, as here, already fenced) would be to have these nurseries 70 yds. apart, each in the centre of the acre it was to stock; but few sites will admit of so perfect an arrangement. The intention is to set out the plants on the surface, turfs and all, after 2 or 3 years' growth in the nursery, when much less draining will be required than would be necessary for small plants. Every fifth plant in every other row is left *in situ*, the nursery thus becoming part of the plantation.

The plants from the first of these nurseries were set out on June 26, 1928, when the R.S.A.S. visited Corrour. It appeared on examination a year later that no deaths had occurred.

Why are the turfs not cut where required and placed at once in their permanent positions? Because there is economy in concentrating all the preparatory work in one spot. Also, the turfs are heavy to handle when first cut, whereas after two years' exposure six or even eight can be carried by two men on a light hand-barrow.

The cost works out at £4 6s. 7d. per 1000 plants, arrived at as follows:—

Labour, preparing nursery, mixing			
compost, and planting, ...	£3	6	2
186 lbs. Basic Slag, including			
carriage, ...	0	5	5
1000 Sitka 3 yr. seedlings from own			
nursery, ...	0	15	0
	£4	6	7

Planting at 6 ft. (1210 plants), the cost works out at £5 4s. 9d., or, say, £5 5s. per acre. To this must be added the cost of setting out the plants. This entails some pulling of heather, but the total expenditure, including some cut-off drains, should not exceed £8 an acre. Where much draining is required, the ordinary turf planting would be more appropriate.

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This method, though much less costly than mound planting, has been condemned by some foresters as too expensive. It may still prove in the long run the cheapest way of establishing plants under these conditions. It is a question of results. All nursery work is expensive. It is much cheaper to drop a seed where you want each tree to grow, but the results are so slow and uncertain that all agree it is usually better to face the expense of a nursery. In this case acclimatization is the essence of the problem, and the production of large, strong plants in order to minimize expense in preparation, planting, and cleaning. These objects can only be obtained by means of a flying nursery; and on a peat-covered moor at 1500 ft., the form of nursery described above is probably as cheap as any that can be devised, besides obviating all risk of check when the plants are moved to their permanent places.

LOCH OSSIAN PLANTATIONS

MANURES.

The first manuring experiments here were made by John Boyd in 1900, when Compartment XVIa was planted. The manures used were kainit and basic slag. They were applied direct to the roots at the time of planting. There was no appreciable result. Probably the doses were too small.

The small quantity of basic slag (about 2 oz.) given to each tree under the Belgian system of turf-planting (see page 44) undoubtedly has a marked effect on the growth for the first few years.¹ This was thoroughly proved in Belgium before the system was adopted, and was tested here by an experiment, now obliterated. On moderately good peat the manure enables the plant to establish itself on the turf and strike out into the drained soil without any check. At Fersit and other places where the manure has been omitted from the turf-planting, the result has been poor except on peat of exceptionally good quality. This was very noticeable at Inverleiver. It is probably not too much to say that without manure the system has as a rule little to recommend it. On very poor peat there is undoubtedly a check when the manure is exhausted, but the plants are too well established to die. A further application of manure again stimulates growth. Whether this will be permanent remains to be seen. We have usually allowed the check to continue too long before giving a top dressing. A rank growth of heather then complicates the problem. It is evident, from an experiment

¹ The daring and very successful plantation of Moorburnhead at Langholm, Dumfriesshire, is apparently an exception, possibly on account of the chemical composition of the soil underlying the peat.

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in Compartment XXII (*q.v.*), that even on fairly good molinia ground a single top dressing of basic slag may make all the difference between success and failure. Here, 19 years after the first top dressing, there is a difference of 22 ft. in average height between the trees that were dressed and those that were not. The first dressing in this case, given in 1908, was very heavy—being at the rate of 3 tons per acre. A dressing of 7 cwt. per acre, given in 1912 to another section of the same plantation, has so far been quite as effective. Most of the control plants are still in the check stage, and few are more than 4 ft. high.

On the Quarry Flat (V), the worst peat we have ever planted, an attempt was made in 1921 to ascertain the amount of basic slag required to stimulate growth after a prolonged check, the value of adding mineral soil, and the effect of lime. The doses of basic slag varied from 10 cwt. to 30 cwt. per acre. Up to 1924, all the trees top dressed with basic slag have responded about equally, the quantity and the presence or absence of sand making little difference. The slag appears definitely more effective than lime. See Appendix II.

A simpler experiment has been made this winter in Compartments XIII and XX on Norway and white spruce, planted on turfs in 1909. Both sites are covered with very bad peat, and there has been on both a check lasting at least 12 years. See Appendix III.

There seems to be so far no agreement among men of science as to how the manure actually works. It appears probable that in the case of basic slag it has the double effect of improving the soil and nourishing the plant, the lime neutralizing the acidity in the peat and the plant benefiting by the phosphate thus released.² Both processes are on so small a scale that the phase is clearly transitional, merely carrying the tree over a difficult stage. Does the tree need a certain minimum of working capital to start its

² See Cousins' *Chemistry of the Garden*, 1924, page 62.

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business? Are friendly bacteria brought into play by the action of the manure, which could not otherwise obtain a footing? In either case, the manure is more than a mere time-saver. Obviously, unless it is used in very large quantities, it is necessary for ultimate success that the soil should be capable of growing trees once they have made a good start and are able to fend for themselves.³

Manure has been used here mainly for pines, spruces, and silver firs, but an experiment in top dressing pit-planted European larch (XVIIIb) shewed that this tree also responds readily to treatment on poor soil. On the soils to which this tree ought to be confined, there is no occasion to use manure, and on them it would probably have little effect.

The use of manure for trees was somewhat discredited among Scots foresters by a series of top-dressing experiments organized for the Glasgow Agricultural College by Mr. Nisbet shortly before the war. These experiments, which were widely tried, included doses of various mixtures given at various dates. On reasonably good soil the effect was nil. Here on the quarry flat they were all equally successful. The control was long a conspicuous blank, but was unfortunately top dressed later. It is due to Mr. Nisbet to say that he never believed in the use of manures except on the poorest soils, where he held them to be of great value. On his suggestion, in 1915, ground limestone was added to the basic slag used in the Sitka plantation at the east end of Compartment IX. There is no difference so far between this plantation and those in which slag was used alone.

³ It must be remembered that it is one thing to apply manure to the roots at the time of planting and quite another to top dress a checked plantation where the roots have had time to spread. In the first case the result depends on the amount of manure per plant: in the other on the amount per acre.

LOCH OSSIAN PLANTATIONS

ADVANCE CROPS AND NURSES.

Every year the value of side-shelter becomes more apparent in these plantations, its protective effect extending to frost and summer drought as well as wind. No deliberate experiments in advance planting have been made, but the whole venture incidentally illustrates the principle. Each year it becomes easier to establish trees among the plantations as compared with open ground. Where the killing of heather is an object, nothing but a complete crop will suffice, and Scots pine is probably the best species. It may not be so good a soil improver nor quite so easy to establish as the dwarf Mountain pine, but it can be used for fencing or pitwood, and a proportion of the trees can be retained as an overhead story, whereas the dwarf Mountain pine is useless for any purpose except fuel, and very laborious to remove. The upright Mountain pine would be an ideal advance crop where time was no object. It has here proved an excellent nurse for spruce, and does not shew any tendency, as in Jutland, to suppress it.

The change wrought by an advance crop of pine must be seen to be believed. Unfortunately, it can be seen without being believed. Under the pine the visitor sees a vigorous growth of the grasses, herbs, and ferns which indicate good spruce ground, and notes the fine colour and generous growth of the spruce. Alongside he sees an area covered with an unpromising mixture of sickly heather and yellow grasses, where much older spruce is hopelessly checked. He naturally finds it hard to believe that so great a difference can be due to the influence of the pine and the drainer's spade. A visitor from Denmark concerned in similar work tells us that he is

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confronted there with the same incredulity. He also finds, as we do, that this incredulity extends to the results obtained by the use of artificial manures. This points to the need of controls on a liberal scale. In these plantations, through a mistaken fear of leaving gaps in the crop, many of the controls have been brought under treatment as soon as we were ourselves satisfied with the result of the experiment.

Except where the object is to kill out the heather and transform the soil, side-shelter could be secured by planting the advance crop in lines or narrow belts at right angles to the prevailing wind. In this case it would make little difference in the end whether the shelter trees were planted in advance of the spruce or not. If planted together, the spruce would simply remain in the check stage till the pines got ahead. If both species were to be manured, they might still be planted together. If, on the other hand, manures were to be used only for the spruce, the planting of this species should be delayed till the pine was established.

It is impossible to apply any of these plans without waste of effort, since one cannot tell beforehand exactly where such precautions will be needed or how much of them. A feasible alternative would be to plant in the ordinary way, and after three or four years introduce Scots pine or Mountain pine where the check stage appeared likely to be formidably long.

White alder is often recommended as an advance crop or nurse, but here we have found it as difficult to establish as the trees it is intended to help.

Whether it is possible to establish spruce here in the open by careful planting without any kind of nurse will be learnt from the fate of the Sitka and Norway in the new Meall Glasuaine ground, XVIII A, B, C, and D.

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PLANTING DISTANCES

In the earlier work here the planting was at 3 to 4 ft., which did very well for Scots pine where the plants were notched in heather. The turf-planting up to 1914 was at 3 ft. For Scots pine, which grew very fast so planted, 4 ft. or 4 ft. 6 in. would have been quite close enough. For Norway spruce, 3 ft. is not too close, but on poor soils, where dense canopy results in too rapid defoliation, this distance entails very early thinning, and 4 ft. seems on the whole the better distance. For Sitka spruce, 4 ft. is perhaps not too close on poor ground, where the first object is to kill out the heather, but on good ground it is much too close. There 5 or 6 ft. is quite near enough. The first thinning of Sitka planted at 3 ft. is the devil's own job.

The distance adopted here since the war for Sitka, Douglas, and Nobilis is 5 to 6 ft., and for Norway spruce 4 to 5 ft. In attempting to reclaim bad ground, such as the quarry flat, it would, we believe, pay us to stick to the same distances, and devote the money which would otherwise have been spent on closer planting to a top dressing with basic slag wherever the growth was checked.

The under-planting has been mostly spaced at 6 or 7 ft., but in some cases it has been as wide as 9 ft.¹

¹ A Sitka wood at Drumlanrig, planted at 9 ft., and still unthinned, appears 26 years after planting somewhat rougher than the closely-planted woods, but its growth is superb, and in the 25th year it already contained almost 6000 cubic ft. to the acre. One can scarcely doubt that at 50 it will prove a better investment than closer plantations, which cost more to make and required early thinning.

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Dr. Mark Anderson's suggestion for Group Planting² appears well worth trying.

The larch on the moraines in Meall Nathrach (XXI and XXII) consisted mostly of 2 yr. seedlings dibbled at 2 ft. This plantation was cheap and successful, but naturally required early cleaning. Since the war any larch we have planted has been pitted at 5 ft.

² *Empire Forestry Journal*, vol. 7, 1928, pp. 22-40.

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COMPARISON WITH PLANTATIONS ELSEWHERE.

Planting in Scotland has naturally been confined for the most part to more promising subjects than the shores of Loch Ossian. There are plenty of woods at higher elevations, but most of these are on the eastern side of the watershed and further back from the sea. In Mar Forest and Atholl there are woods which reach almost, if not quite, 2000 ft. At Glenlochsie, near the Spittal of Glen-shee, in the Forfarshire forests of Caenlochan, Glendoll, and Invermark, and on Donside, there are woods well above the 1500 ft. contour. But in all these places, except perhaps the Atholl woods between Dalnacardoch and Dalnaspidal, the conditions are quite different from those which obtain in the Braes of Lochaber. Closer parallels, but still across the watershed, are found in the neighbouring plantations of Ardverikie and Ben Alder, and in the 80-year-old wood at Loch Kennard in Perthshire. In all these ventures Scots pine and larch have played the prominent parts, and spruce can only be judged from small groups and isolated trees. At Loch Kennard, 1350 ft., the spruces have reached a height of 50 ft., being 20 ft. taller than the Scots pine. In the Loch Ericht wood, 1150-2000 ft., planted 1875-1881, they are over 70 ft., but very rough, through the failure of the matrix of Scots pine. In the plantations surrounding Loch an Earba, 1142 ft., in Ardverikie Forest, larch and Norway spruce have attained a height of 48 to 55 ft. in 40 years, with an average girth of 43 inches at 6 ft. The 70-year-old wood behind the Black Mount Lodge on Loch Tulla contains Norway spruce 70 ft. high on fairly deep peat. In the Kerry woods, on the borders of Wales and Shropshire, Norway spruce was planted pure on a large scale, and has proved its value as a mountain tree with a volume of 4500 to 6000 cubic ft. (in the dominant crop), at the age of 43, at an elevation of 1400 ft.¹

¹ Notes on Kerry woods, by R. L. Robinson. *Journal of Board of Agriculture: Supplement*, August, 1912.

COMPARTMENT NOTES

COMPARTMENT NOTES

LEITIR DHUBH

COMPARTMENT 1A.

84.6 acres. Altitude, 1269-1650 feet. Aspect North. Soil, partly loam, partly peat, over glacial drift. Underlying rock Loch Treig Schist. All plantable.

Natural birchwood, unenclosed, on a steep face, with rowan, alder, willow and a few bird-cherries. Consists of ragged old trees belonging to the pre-sheep period, and seedlings dating from the time when the sheep were cleared and deer not yet numerous. The deer now devour all seedlings, a few old trees come down every year, and the wood may soon require to be enclosed if it is to be preserved at all. It should in any case be kept as a natural wood. As such it has more interest and beauty than any plantation could have. Dr. Eagle Clarke has here recorded the highest nesting places in Scotland of several birds.¹

A few specimen trees near the road, chiefly conifers, and two small clumps were planted in 1892 by Howden & Co., Inverness. Some specimens were replaced later.

¹ See Appendix VI.: Also *Scottish Naturalist*, November and December, 1917, and January, 1918.

LEITIR DHUBH

The best trees near the road measured:

	October 1912.	October 1928.
<i>Picea orientalis</i> ,	15½ ft.	33 ft. x 30 in.
<i>Picea jezoensis</i> ,		30 ft. x 21½ in.
<i>Abies grandis</i> ,	17 ft.	49 ft. x 24½ in.
<i>Abies nobilis</i> ,		46 ft. x 32½ in.
<i>Abies balsamea</i> ,	22 ft.	44 ft. x 39 in.
<i>Abies Veitchii</i>		35 ft. x 26½ in.
<i>Tsuga Albertiana</i> ,	27½ ft.	43 ft. x 46 in.
<i>Tsuga Pattoniana</i> ,		26 ft. x 23 in.
<i>Thuja plicata</i> ,		30 ft. x 28½ in.
Aspen,	24 ft.	40 ft. x 23½ in.
Sycamore	20½ ft.	32 ft. x 18 in.
<i>Pinus cembra</i> —slender sort (left of path to Old Lodge),	14 ft.	
<i>Pinus cembra</i> —bushy sort (right of same path farther on),	17 ft.	

The best trees in the larger clump measured:

	October 1912.	October 1928.
<i>Picea sitchensis</i> (outside tree),	33½ ft.	55 ft. x 45 in.
<i>Picea sitchensis</i> (inside tree),		50 ft. x 34½ in.
<i>Abies nobilis</i> ,	30½ ft.	56 ft. x 57 in.
<i>Picea orientalis</i> ,	16½ ft.	33 ft. x 32 in.
<i>Picea pungens</i> ,	13½ ft.	26 ft. x 20 in.
<i>Picea morinda</i> ,	10½ ft.	22 ft. x 15½ in.
<i>Tsuga Albertiana</i> ,		43 ft. x 41 in.

This clump was enlarged 1912-13 to about 2 acres, and planted with groups of *Abies nobilis*, *grandis*, *pectinata*

LEITIR DHUBH

and *Lowii*: *tsuga Mertensiana*: *larix occidentalis*?: *picea jezoensis* and *Breweriana*: *nootka cypress*: Douglas, green and blue: with a windbreak of common larch and Sitka spruce. A group of hybrid larch was added in 1925.³ The *nobilis* fir has been attacked by *Rhemiopsis bohemica*. The fungus seems to have been checked by cutting out the worst trees and pruning and spraying the remainder, but not eradicated, as it reappeared this summer.

The path through the birch wood was constructed in 1910-12.

² Raised at Pollok from seed gathered by Mr. M. J. Elrod at Bigfork, Montana, U.S.A., 1908.

³ Eastern half from seed gathered at Dunkeld from trees of second generation: western from trees of first generation in garden at Keir. The Keir trees were raised at Dunkeld.

LEITIR DHUBH

COMPARTMENT IB. (Clach Mhor).

9.1 acres. Altitude, 1280-1490 feet. Aspect N.W. Elevation 1279-490 feet. Loam and peat over Loch Treig schist. The best soil yet enclosed. Enclosed 1922. Planted 1923-5. Birch removed before planting and some of the long heather burnt.

Between road and loch, Sitka on turfs. Between road and path the following mixtures—Sitka and Douglas, 3 to 1 and 1 to 3. Sitka and Nobilis, 3 to 1 and 1 to 3. All at 6 ft. The Douglas mixtures were kept on the upper and more loamy ground. Unfortunately the Douglas plants (bought in) were lanky and unsuitable and many had to be replaced. On wet ground blanks were made up with Sitka, so this tree bulks more largely than originally intended. The Sitka at the east end is from Alaska seed. The corner next the road gate is planted with beech and sycamore. The red maples along the road, raised at Keir, were a present from A.S. At the east end of the compartment an exposed bank below the path is planted with Wilson's new Chinese conifers and a few Norway spruce from cones gathered by A.S.M. and J.S.M. on the Rigi at 4000 ft. The group of *Ab. lasiocarpa subalpina* above the path was a present from F.R.S. Balfour of Dawyck. The birches beside these groups were raised at Pollok from Forrest's seed No. 22520. Above the path are Norway spruce and hybrid larch. The latter not planted till 1927.

The temptation to increase this plantation at the expense of the old birch wood should be resisted. It is doubtful whether the encroachment already made can be justified.

ISLANDS

COMPARTMENT II.

2.5 acres. Altitude, 1269-1280 feet. Aspect, open on all sides. Soil, peat on boulders and gravel.

Ten small wind-swept islands on Loch Ossian with scanty remains of birch and rowan. Invaded by hares and deer in winter.

Planted 1892 with Scots pine and a few Austrian pine, the latter nearly all dead. The Scots pine succeeded best on an Island which was burned the autumn before planting. A few larch were planted at the same time on the promontory opposite the pier. These, the first larch planted on Loch Ossian, were in October, 1912, 22 feet high. Unfortunately most of them have since been destroyed by deer.

The larger island should be drained and planted on turfs with Scots pine or mountain pine. If it is possible by a small amount of fencing to protect any of the adjacent promontories from deer and hares, they might be planted with advantage to the landscape.

It is remarkable that the pine on these islands has not so far suffered from exposure. The herons build in the pine trees on one of the islands.

BOAT HOUSE PLANTATION

NOTE ON COMPARTMENTS III.—VII.

Altitude, 1269-1680 feet. Enclosed 1893. A good deal of the long heather burned the same autumn. Planting began that autumn and continued in the spring of 1894 and 1895 under John Boyd's supervision. Scots pine at 4 feet with a few groups of other conifers which have mostly disappeared. The intention was to make an open, picturesque wood which would afford both shelter and grazing for deer. Contrary to Boyd's advice, there was no draining, and only the drier parts were planted. The plants brought from Pollok and other Lowland nurseries rapidly dwindled and remained practically invisible till 1901 when a few began to appear above the heather. In October, 1912, the tallest were not more than 15 feet, and a large proportion still under 5 feet. On the higher ground few had even reached the modest height of 3 feet in 18 years. In 1904 and 1905 the line of the fence was altered at the top to avoid snowdrifts. In 1908 the lower part began to be taken in hand (see Sections IV and V). The method is that which is to be applied to all these plantations:

- (1) To drain the existing Scots pine wherever it is not beyond recovery.
- (2) To plant larch on every scrap of suitable ground.
- (3) To make the remaining ground solid with spruce planted on turfs.

Three paths are intended to traverse this plantation from east to west. The middle path forming the compartment boundary has been constructed. So has the lower path with a junction to the road near the quarry. The upper path has still to be made.

BOAT HOUSE PLANTATION

COMPARTMENT III.

31.7 acres. Altitude, 1269-1335 feet. Aspect, North. Partly on granulate and partly on schist, with some patches of alluvium. Peat everywhere, but only a few inches thick on the knobbies.

The Scots pine of 1894-1896 was confined to the better ground. It was drained at various times from 1906 to 1912, where it showed signs of growing, and parts were beaten up with mountain pine on turfs. It was cleaned and thinned 1916-17, and the birch cut out, which we now regret. A few nobilis and Douglas from the first planting came to light near the boat house. The pine was thinned again gradually between 1922 and 1928, and beaten up with Sitka transplants from the Quarry Flat.

In 1902, and the following years, an attempt was made to establish birch on the promontories at the extreme ends of the section, but it has not been successful. In 1911-12 the trenched birch clumps on the point opposite the Lodge were under-planted with mountain pine and Sitka spruce, and the rest of the hillock was drained and beaten up with mountain pine. Groups of nobilis were added in 1917. The Scots pine scattered among the Sitka and nobilis are survivors from a broadcast sowing made in the trenched ground in 1908. In 1926 the gaps in this promontory were filled with Sitka transplants.

The group of oriental spruce in the Boat House bay was planted about 1900, large plants from Veitch's Kingston Hill nursery, which did no good till they were top dressed ten years later. One of the best now measures 20 ft. by 23 in.

1914-15. The molinia flat behind the boat house was drained and planted with nobilis fir on mounds at 6 ft. The trees where checked were top dressed with basic slag in 1924.

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The slope adjoining this flat and immediately below the road has been very troublesome owing perhaps to the poverty of the underlying granulite. After two plantings of Scots pine had failed, it was planted with Norway spruce 1910-11, 2-year seedlings on turfs. The heather was pulled round the plants in 1922 and they were top dressed with basic slag in 1923-24. The growth is still unsatisfactory, except near the road where mineral soil has no doubt percolated into the peat. A few of the spruce next the road date from the first planting. For this type of ground we should now use Sitka.

A little further to the south-west of this, an acre or so stretching from the road to the loch, was planted in 1911 with Scots pine raised from seed gathered in the Cranachan wood and the wood on Loch Tulla. These are both old natural woods. The plants, 2-year seedlings on turfs, were very small. They were in October, 1929, 6 to 16 ft. high. The needles seem smaller and the branches shorter than those of the other pines here which are probably mostly from Strathspey or Moray. It is a pity this plantation is not on more typical pine ground. This is so unsuitable that most of it will have to be converted into spruce.

The group of Sitka beside the road near the site of the old gate was planted under birch trees 1910-11, lanky plants from Germany, badly frosted after planting. The best in October, 1929, measured 34 ft. by 17 in.

This compartment has been left more or less open for the sake of the view from the road, but one or two flats might still be drained and planted with spruce.

BOAT HOUSE PLANTATION

COMPARTMENT IV.

17.9 acres. Altitude, 1325-1510 feet. Aspect, North and North-West. Steep ground, mostly covered with peat, but good planting ground. The junction of the Loch Treig schists and Corrour granulite occurs about the middle of this compartment. Partly planted with Scots pine 1894-1895. One ridge near the south-west end was planted at the same time with dwarf mountain pine, and below this among the birches, with Colorado Douglas, the tallest about 20 ft. high in October, 1929. A good deal of this end of the compartment was left open in the hope that birch would spread. It has done so grudgingly and only in the hollows. The ridges were planted with Cembra pine, but it has been attacked by *Brunchorstia* and will have to be replaced by something else. Two hollows where the Black Wood path diverges from the road were planted with Japanese larch 1911 to which a few Veitch's fir were added in 1919.

In 1917 the face above the road east of the above was thinned and underplanted with common silver fir. Other parts of the same were filled up in 1919 with *nobilis* fir. Part of this face was again thinned in 1926. Some gaps have been filled with Sitka or Norway spruce, but future treatment mainly depends on the fate of the silver. It is proposed to interplant it with beech. The soil is good and ought to grow something better than the twisted pines and larches which survive from the first planting. In 1927 the quarry path was extended to join the Black Wood Path at the Rhododendron Ridge.

The group of Sitka beside the road near the old line of the fence was planted 1910-11 at the same time as the group opposite in Compartment III, but in this case small plants from the Pollok nursery were used. They

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were notched under birches since removed. The tallest in October, 1929, measured 34 ft. by 28 in.

Two groups of nobilis fir beside the road near the quarry were planted in 1919, large plants on mounds. The plants came from Lowther in Cumberland and were put straight out. They were as good as plants could be, but many died and all hung fire, shewing the danger of so abrupt a change. They were top dressed with basic slag in 1923. The peat here is very deep near the road. In draining it below the quarry we found the largest ancient log we have yet unearthed. (See Appendix I.). The upper part of this compartment is to be made solid with Sitka from the turf nurseries in Compartment VII.

The birch covered ridges at the south-west end of the compartment have been reserved for rhododendrons. planted from 1910 onwards. (See page 36).

BOAT HOUSE PLANTATION

COMPARTMENT V.

26.4 acres. Altitude, 1275-1510 feet. Aspect, North. Soil, dry banks alternating with flats of deep peat. All on the granulite, except a few yards at N.E. end.

Planted 1894 and 1895 with Scots pine—the drier parts only—and groups of other conifers which have nearly all disappeared except a few Nobilis, Douglas, and Norway spruce near the Boat House. Most of the spruce and all the mountain pine date from 1909 onwards.

1908-1910. Scots pine drained from quarry eastwards. Beaten up with mountain pine on turfs. The Scots pine improved so much after draining that most of the mountain pine was suppressed. Some gaps were drained and planted with mountain pine pure. Norway spruce was inserted among these in 1914-15, and has done remarkably well.

1909-1910. Wind-break of birch and mountain pine constructed below quarry, and the flat eastwards, about 5 acres, planted with spruce—Sitka, Norway, and white, in separate blocks—2-year 1-year, on turfs, in the Belgian manner, with sand and basic slag. In June 1911, after a long drought, this planting looked extremely well. It was never beaten up. The deaths in the Norway spruce were under one per cent., in the sitka spruce and white spruce under two per cent. The sitka spruce was brought in and planted straight out. The other plants were raised at Pollok. Some Banks' pine, also planted on turfs, were less successful. They were leggy plants from Germany which had heated on the journey. This quarry flat is the poorest piece of ground we have planted. In 1912 the growth declined and the plants turned yellow. The drains were deepened and the

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debris was thrown round the plants. This was probably a mistake, though for the moment it was successful. The following year the trees, which Cameron had likened to plumes on a hearse, amended their shape. In 1914 and 1915 the growth was spoilt by late frosts. In 1916 the spruces settled down to the slow but persistent growth which they assume on the poorest soil. Was overdraining partly to blame? In 1919 the Sitka in the corner next the quarry was top dressed with basic slag, two handfuls being given to every alternate tree. The whole crop responded, shewing that the roots were much interlaced. In 1920-21 a series of top dressing experiments were made (see Appendix II). 1924-27 the whole of the rest of the flat was top-dressed, including the white and Norway spruce, with basic slag at the rate of 15 cwts. to the acre.

One group of Sitka near the west end of this flat, and a few yards from the road, was planted on peat from which the top spit had been removed for road edgings. It grew well from the first, though for several years the trees assumed a pale lemon colour in winter. Without any aid from top dressing their colour is gradually becoming normal, but they are still, after nineteen years growth, paler than their neighbours, and taller, though they have not been top dressed.

The spruce has grown much better on the slopes. It was all planted on turfs 1910-12, except that inserted among the mountain pine which dates from 1914-15. Some parts are nearly as poor as the quarry flat described above. They have been top dressed with basic slag at the rate of 15 cwts. to the acre. The sloping ground promises to make a fine wood in which spruce will predominate. The Scots pine was heavily thinned in 1926 and transplants of Norway spruce were introduced with the idea of ultimately eliminating most of the pine.

The group of *thuya plicata* at the north-east end of the compartment beside the lower path was planted 1912. It

BOAT HOUSE PLANTATION

was eaten to the ground by hares in the hard winter of 1915-16, but has made a good recovery.

Part of the steep slopes below the middle path was planted with rowans in 1926 for autumn colour. A zone all along this path should be kept fairly open for the view.

An area near the middle of this compartment was planted with *nobilis* fir on turfs by Miss Mary Sutherland's squad of girl foresters in 1917. It was cleaned in 1927 and top dressed in 1929. Below this there is some good Sitka planted in 1912.

There is still some blank ground at the top of this compartment next the ride for which turf nurseries have been constructed in Compartment VI.

BOAT HOUSE PLANTATION

COMPARTMENT VI.

24.9 acres. Altitude, 1410-1680 feet. Aspect, North. Soil, peat of good quality over glacial drift and granulite rock.

Planted 1894-1895 with Scots pine and a few *pinus cembra* and larch—the drier parts only. 1911-1912, the turf-planting from Compartment V was continued for about an acre, with sitka and Norway spruce, into the N.E. corner of this compartment. In 1918 part of the pine adjoining this was underplanted with Sitka and Norway.

1912-13. Two hollows above the middle path planted with *picea Englemanni* and *pinus Murrayana*, as a first trial of these species.

1917. Two long hollows drained in 1915, but left unplanted for want of labour, were planted by Miss Mary Sutherland's squad of girl foresters with *abies nobilis* and *picea Englemanni* on turfs. The *nobilis* has made poor progress, but most of it is alive. The heather should be pulled round the plants and a top dressing of slag given.

As this compartment, like No. VII, is clearly more suitable for spruce, and the pine has been badly punished by snow and wind even where it grew well for the first few years, it has been decided to put most of it under Sitka. Turf nurseries (see page 53) have been made for this purpose. The first batch has been planted out this summer, 1929.

The fence should be moved between the high gate and the second strainer east of it, so as to include the whole of the Knobbie which it now crosses.

BOAT HOUSE PLANTATION

COMPARTMENT VII.

17.4 acres. Altitude, 1460-1665 feet. Aspect, North and North-West. Soil, for the most part fairly good, especially near Birch Wood where underlying rock changes from granulite to mica-schist.

Planted 1894-1895 with Scots pine—drier parts only. Ridge next the Black Wood fence planted with dwarf mountain pine.

This is really spruce ground and is to be treated as such, retaining some of the surviving pine as shelter. Turf nurseries have been made.

The summit is on the granulite and very poor soil, the sort one would prefer to leave unplanted in so exposed a situation. As it is, however, not more than an acre, and is the highest ground enclosed, we propose to make the experiment of planting it. A mixture of contorta pine and Sitka spruce would seem best or Sitka and dwarf mountain pine.

The earliest turf nurseries were constructed at the east end of this compartment in 1926. The first to be planted out (as a demonstration for the R.S.A.S. on June 26, 1928) was where the ride dividing Compartments VI and VII crosses the line of the high path. All the plants round about this crossing came from this nursery, but the bulk are to the west of the compartment ride.

LAP PLANTATION

NOTE ON COMPARTMENTS VIII.—XV.

Altitude, 1269-1565 feet. Enclosed 1895. A reckless enclosure, including a lot of bad ground and very little good. Planted by Howden & Co. by contract, 1896 and 1897. Only the drier parts planted, the intention being the same as in the Boat House, q.v. Scots pine was the prevailing species, but, unfortunately, most of the best ground was devoted to an attempt to establish birch, rowan, and alder by notching, which proved a complete failure. The Scots pine made a rather better start than in the Boat House, possibly on account of the warmer aspect, but the plantation as a whole was so unpromising that it was left to its fate until 1906.

In 1911 a new line for the fence was provisionally marked out, excluding 88.7 acres of the worst and highest ground (see XV). The new line is laid out with a view to shelter for deer. The zone immediately inside it should be made solid. No need to move the fence until the shelter is sufficient to warrant the expense. Meanwhile the fate of the area outside the new line remains in suspense, but parts of it may deserve to be fenced separately and should be treated accordingly (see XV).

LAP PLANTATION

COMPARTMENT VIII.

35.3 acres. Altitude, 1269-1460 feet. Aspect, South. Soil, above the average.

The Scots pine, which alone survives from the first planting of 1896, made a good start, but would have been greatly helped by earlier draining. In 1910, when it was seen to be going back, an experiment in draining was made at the south-east corner of this compartment, and was continued on a larger scale in 1911. Parts of the ground drained were beaten up with mountain pine.

Some of the hollows in this compartment should be left unplanted so as to give a broken and picturesque end to the plantation as seen from the loch, but a good deal of ground where birch and rowan have failed, may still be planted.

LAP PLANTATION

COMPARTMENT IX.

36.4 acres. Altitude, 1269-1455 feet. Aspect, South. Soil, good banks alternating with peaty flats and some rocks.

A good deal of this compartment was planted in 1897 with birch and rowan which failed. Hence a good deal of the best ground is vacant.

1914-15. East end of this compartment drained and planted according to soil with larch, Norway spruce, and Sitka spruce. Here by Mr. Nisbet's advice we introduced White Alder for the first time among the spruce, in the proportion of 1 to 5 (*i.e.* alternate in the middle row) where the turf-planting was done on the plan hitherto followed. Mr. Nisbet, however, thought we were planting too close and advised making the drains to their full depth at once instead of taking out only the turfs required for planting and deepening them two years later. His plan was as follows. Drains 12 feet apart (centre to centre), 2 feet wide at top and 2 feet deep. The output to be used to make mounds on which to plant instead of single turfs. Two rows of spruce 6 feet apart and the plants 6 feet apart in the rows. Between the rows, a row of White Alder quincunx-wise. This gives 1 alder to 2 spruce and spruce at 6 feet. Mr. Nisbet also proposed a change in the manure. In addition to the basic slag and sand (1 to 7) hitherto employed, he advised giving an equal amount of a mixture composed of ground lime and sand in equal parts, *i.e.*, 4 handfuls for each plant composed as follows: basic slag 1, ground lime 4, sand 11. This experiment was made near the loch side 50 yards east of Clach Bhiorach with Sitka spruce, small and rather shabby 2 year 2-year plants which were frosted after

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planting. In January, 1917, the spruce looked extremely well, but most of the alder had been eaten by hares. They were replaced by spruce. A good deal of the larch has failed and part was beaten up with Sitka in 1925. The flat along the loch side east of Nisbet's plantation does not appear worth planting. The bank behind it has been planted this year (1929) with hybrid larch. Above is a belt of pine. Behind the pine there is a long stretch of nearly flat ground between this and the next ridge. This flat, part of which falls gently to the east, appears suitable for Sitka.

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COMPARTMENT X.

19.5 acres. Altitude, 1269-1460 feet. Aspect, South. Soil, peat, varying in depth, over glacial drift.

The slope next the loch has scattered groups of pine from the 1897 planting, and is to be treated for beauty, the hollows being left open. Birches, rowans, bird cherries, aspens, and thorns are to be added, and perhaps a few beech and oak, but no spruce. At the west end where the soil changes, a large group of Omorica spruce has been planted this year.

Behind this slope there is a band of larch planted about 1914, but only now beginning to grow. The blanks should be made good with Sitka or beech, and it should be joined up to the pine on the ridge above it. Above the pine there is some ground suitable for spruce on mounds or turfs.

LAP PLANTATION

COMPARTMENT XI.

23.4 acres. Altitude, 1269-1460 feet. Aspect, South and South-East. The northern half of this compartment is on the granulite: the southern on the Loch Treig schist. The dividing line starts from the mouth of the Lap Burn and crosses the compartment diagonally. The face next the loch is good ground with little peat except in the hollows. The bank next the Lap Burn, though on the granulite, is also fairly good.

The Scots pine on the loch side planted in 1897-9 grew very well till 1923 when it began to shew the effects of a series of cold summers. The same year, after an autumn thinning, it was badly broken by snow. It should have been thinned earlier. The better part of this face should now be treated for amenity on the lines prescribed for Compartment X. The section next the Lap Burn is so poor that it may have to be put under Sitka.

The east end of this compartment, above the Lap Burn bridge was drained and planted with larch and some Sitka, 1907-8. Canker and chermes made havoc among the larches, and in 1925-6 they were replaced for the most part by Sitka transplants brought across the loch from Compartment XIX. For the cost of this see Compartment XVIa. A few Douglas were also planted here.

The flat next the Lap Burn and horse shoe bank above were planted in 1908 with supposed western hemlock. It was constantly frosted and proved to be the eastern form, *T. canadensis*. It was gradually replaced, 1912-18, with Sitka, Norway, *nobilis*, and *grandis*. The group of aspens is natural.

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The Scots pine behind this was planted on turfs about 1903.

Higher up the burn a hollow was fenced against hares in 1908 and planted with Weymouth pine. It grew well enough, but was constantly cut back by frost. In 1912 every other tree was replaced by nobilis fir, very small plants. Another group of nobilis still higher up the burn was planted in 1923.

Part of the unplanted ground at the top of this compartment was drained and planted in 1915 with upright mountain pine. This plantation might be extended to give this tree a good trial. The hollow below appears to be good spruce ground.

A good deal of ground at the top of the compartment is still vacant, and probably not worth planting.

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COMPARTMENT XII.

15.2 acres. Altitude, 1269-1400 feet. Aspect, South-East. On the granulite. Soil, varies more than usual. Some good stony soil near the burns, especially at Luibna-Lap. Very little here from the first planting, 1896-1897, except a few clumps of Scots pine.

In 1906-1907 part of the flat at the mouth of the Lap Burn was fenced and planted with the following hard woods in pits with basic slag: Sycamore, Norway, maple, ash, black Italian poplar, Spanish chestnut, horse chestnut, *betula papyrifera*, *betula maxmowicksii* (grafted), wych elm, walnut, hazel, lime, Turkey oak, scarlet oak, beech, and sessile oak (2-year seedlings). Also in 1908 groups of Weymouth pine and omorika spruce. Four specimens of *larix occidentalis* (Idaho seed), a present from Mr. H. J. Elwes, were planted in 1908 near the path, but were killed by the May frosts of 1921. One had attained the height of 30 ft. A larger group (raised at Pollok from seed gathered by M. J. Elrod, Bigfork, Montana, U.S.A., 1908) was added 1913. Also, outside the gate, a few *L. Americana* (Tamarack) from seed gathered by James Kay, Indian Head, Sask., Canada, 1909. The rowans, birches, and alders, and a few ash and sycamore in this enclosure date from 1897. Some of the hard woods were destroyed by hares in the severe winter of 1915-16. Groups of *pinus Peuke* and *pinus monticola* were planted 1918. A few silver firs lifted at Gerardmer before the war, were planted here in 1920. More beech was planted in 1923. Several varieties of birch, pyrus, maple, etc., have been added at various dates between 1920 and 1926. The first plants of *populus tricocarpa* date from 1922.

The flat north-east of the enclosure and adjoining slopes were planted with Sitka spruce in 1908 and 1909,

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mostly 2-year seedlings on turfs. The death rate among the seedlings was heavy, and we have never used this class of spruce again. The species are also at this age difficult to distinguish, and in this instance a good deal of white spruce crept in by mistake. Perhaps we may, like the Danes, be lucky enough to obtain a serviceable hybrid between the two. Much of this plantation is on poor ground, and in parts there is only a thin covering of peat over the granulite. It was beaten up in 1910. In 1916 the tallest trees averaged 10 ft.: the smaller not more than 3 ft. 6 in. The best groups were thinned in 1923 after an attack of leaf shedding. One dominant Sitka removed measured 19 ft. by 12 in. Its top had been twice broken. The largest white spruce removed measured 14 ft. 3 in. by 6½ in. The worst parts of this planting were top dressed with basic slag in 1924. The best Sitkas averaged 20 ft. by 12 in. in October, 1928.

The grandis fir at the south-west corner of this plantation was added in 1914, the ground having been 5 years earlier planted with dwarf mountain pines among which the grandis were inserted.

Between the enclosure and the loch, the site of an old shieling, the Scots pine of the first planting grew well. Later it fell victim to snow. The delta of the Lap Burn has now been devoted to Douglas and Sitka. The first consignment of plants near the path came from A.S.M.'s nursery at Pollok and were planted in 1920. More were added at various dates up to 1926.

Mounting the burn there are above the enclosure groups of nobilis fir, 1909, and oriental spruce, 1908. The latter were planted as 2-year seedlings. The nobilis are on a deep molinia peat. The tallest in November, 1921, measured 21 ft. 10 in. by 14 in. In October, 1929, it measured 32 ft. by 20 in.

The Scots pine of the first planting on the stony ground below the path to the west of the Ruidh Burn was for

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many years the best we had to show. It has lately been cruelly smashed by snow. Near the loch the ground was swampy. The pine did not thrive. About 1910 it was drained and underplanted with Norway spruce. The pine then shot away with extraordinary vigour. It flourished for 8 or 10 years, then began to die off as it always does on molinia ground. Meanwhile it had killed out a great part of the spruce for which this soil is really suitable, a warning to be remembered. In 1928 the worst of the pines were cut out and Sitka transplants introduced. The oldest Douglas in the burn date from 1908. The White pine near the loch dates from 1911. The hybrid rhododendrons were planted in 1928.

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COMPARTMENT XIII.

16.6 acres. Altitude, 1360-1555 feet. On the granulate and completely covered with peat. On the west the ground falls steeply to the Lap Burn. To the east a long gentle slope.

Planted with Scots pine in 1897. Result very poor. In 1909 much of the ground was drained and replanted with Norway and white spruce. Its condition of total check since the manure was exhausted proves that we have here to deal with a very bad type of peat. As the ground is drained and the remains of the pine give some shelter, an attempt should be made to bring it under Sitka, except where the Norway or white spruce can be revived by top dressing. This is the type of ground on which Sitka always does better than Norway. It is a case for turf-nurseries.

Two top dressing experiments were made here in 1927. See Appendix III.

LAP PLANTATION

COMPARTMENT XIV.

38.2 acres. Altitude, 1365-1555 feet. Aspect, South. Soil, nearly all peat except the face below the rock.

This section is very empty. Only a few clumps of Scots pine remain from the planting of 1895, 1896.

The good slope below the rock should be planted, and the belt next the new line of fence made solid for shelter.

The most exposed ridges seem only fit for mountain pine or *P. contorta*.

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COMPARTMENTS XVA, XVB, and XVC.

These compartments contain 30.6 acres, 26.6 acres, and 31.5 acres respectively, making 88.7 acres in all. Altitude, 1360-1565 feet. Aspect, South-East. Peat of varying depth and mostly very poor quality over glacial drift. Underlying rock, granulite.

The intention in 1913 when the first edition of these notes was printed was to move the fence and exclude all this ground from the plantations, as well as the upper part of Compartment XIII. This intention was based on the failure of the Scots pine planted 1896-8. The fence has, however, not been moved. Some of the Scots pine is alive though in wretched condition. Some of the larches on the hard knolls have grown surprisingly well. When the better compartments are in order it would be interesting, if the result of improved methods in planting justifies the expense, to make an attempt to bring this area under spruce and larch. An advance experiment might be made at the east end in XVC, where some mountain pine has been introduced at various dates and some draining has been done. If the attempt proves a failure the fence might be moved so as to exclude nearly all XVB and about half of XVA, about 40 acres in all. The knobblies treated with mountain pine would remain in. At the west end the new line of the fence would strike the old at the point where the latter now turns outwards.

and XVC/

55/-

MEALL GLASUAIN PLANTATION

NOTES ON COMPARTMENTS XVI.—XVIII.

Altitude, 1269-1500 feet.

This enclosure began in 1898 with a small area round the Lodge which now forms Compartment XVII. It was extended in 1899 by the addition of XVI_A and in 1919 by the much larger area included in XVIII_{A-F}. A section of the Lap enclosure (XVB) is now for convenience also included, as it lies to the east of the narrow neck where the plantations meet.

XVI_A was planted by R. Bryden, 1900-1, under John Boyd's supervision. The 1919 addition was very carefully planted by Simon Cameron, this being our first opportunity of applying much dearly won experience to a new plantation. It is not yet completed. The fence was moved by Donald Stewart on contract. The new line is scarcely longer than the old, though it includes an additional 44 acres.

The whole of this plantation, except part of XVB, is on the granite and fairly good planting ground. There is a good deal of peat, but it is of the type which grows spruce well.

The rides in the post-war addition to this plantation were laid off with some care before planting began. That leading down from the high gate to the Lodge might perhaps be made into a path. The others require some levelling.

MEALL GLASUAINE PLANTATION

COMPARTMENT XVIIA.

22 acres. Altitude, 1269-1365 feet. Aspect, South. Soil, above the average. Peat, nowhere very deep. Glacial drift over granite.

Enclosed 1899, and planted by R. Bryden under John Boyd's superintendence, 1900-1901. Some draining was done, but nothing like enough. Hardly anything but the Scots pine and dwarf mountain pine and a few groups of larch and spruce survive from the first planting. Some thousands of birch and rowan were notched in, experiments being made with basic slag applied both to the roots and on the surface, but without success. The doses were probably too small. There was no Sitka in the first planting. Most of the Norway spruce remained stationary for nearly 20 years.

One small clump of Norway spruce near the Strathossian path planted on molinia ground about 2 ft. by 2 ft. grew from the first. The close planting no doubt helped. The tallest measured 10 feet and over in October, 1912, proving that the species can thrive here if once established. In December, 1916, the tallest tree measured 17 ft. 9 in., and the average height was about 13 ft. Scots pine of the same planting averaged about 7 ft., and the tallest did not exceed 14-15 ft. Larch of the same planting averaged 14 ft., the tallest we could find measuring 22 ft.

This small spruce clump had so much influence on subsequent operations that its history may be followed up here. In 1918 a few suppressed and 7 partially suppressed trees were removed. The following spring the branches were still green to the bottom. By the end of an unusually dry summer the lower branches had completely cast their leaves. In June 1920 a thinning

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was made, 24 trees being removed with an average height of 15 ft. The tallest was 17 ft. 6 in. They were bare of leaves for half their height. In November, 1921, 13 more trees were removed. Average height, 15 ft. 2 in. Tallest, 18 ft. In July, 1924, with the assistance and advice of H.S.S. we removed another 17 trees. Average, 16 ft. 7 in. by 7 in. The largest, 20 ft. 3 in. by 10½ in. In November, 1927, 12 more trees were cut. None dominant. Average height, 19 ft. 4 in. Tallest, a Sitka on edge of group, 22 ft. A few suppressed trees were also removed and the lower branches of the outside trees pruned. The group now includes a few Sitka on the east side. These, though 8 years younger, have caught up the Norway. The tallest Norway measured in October, 1929, 30 ft. by 17 in., the average being about 25 ft. The outside trees are now the tallest, proving that the centre was thinned too late.

1904-1908. Some small patches on the peaty flat near the Lodge and others on the slope above the path were trenched and planted with birch. Those above the path were replanted with nobilis in 1916 and 1917.

In 1906 some parts of this compartment hitherto vacant were planted with Scots pine 2-year seedlings. Very few deaths, but a prolonged check.

In 1908 the wet flats hitherto untouched were drained and planted mostly on turfs with Scots pine, mountain pine, and spruce (Norway and Sitka), and some of the more exposed ridges were planted with mountain pine. Unfortunately, the bulk of the turf planting was done with Scots pine which has broken down under snow. The Norway and Sitka spruce have both done well, and had all the turf planting been done with these species there would have been little to do now. Practically the whole of the turf planted pine has had to be replaced by spruce. The white spruce near the Wild Cat Burn was planted on turfs in 1909.

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In 1910-1911 the better groups of the 1899 Scots pine were drained, and the drains of the 1908 turf planting were deepened.

1918. A ride was cut through the compartment from east to west.

1919-1920. The east end of the compartment was beaten up with transplants of Sitka and Norway spruce from the adjoining turf-planting. This was done in summer. Though both summers were dry and some of the plants 6 ft. high there were few casualties.

1924-1929. A thorough overhauling of the compartment from east to west was undertaken after serious snow damage, the pine being interplanted with Sitka, nobilis, Douglas and Norway spruce. A good deal of Sitka was brought across the loch from Compartments V and XIX. This work, including lifting, transport, and replanting in pits, cost 2 $\frac{3}{4}$ d a tree. Twenty-four trees were transplanted per man per day. Each man carried two trees, one in each hand. Fifty-four trees were ferried across the loch in the heaviest load. The diameter of the balls averaged 1 ft. 6 in. The work was done in July, and there were very few failures.

The Norway spruce planted in 1926-1928 near the east end of the compartment had been lined out at Corrour for two years and was ideal for the purpose. It was planted in pits, or where draining was necessary in mounds. No manure was used, but on the heather ground below the middle ride it was top dressed with basic slag in February, 1927.

The pinetum is described under Compartment XVIb.

MEALL GLASUAIN PLANTATION

COMPARTMENT XVIIb.

13 acres. Altitude, 1269-1420 feet. Aspect, South-East. Peat over drift. About equally divided between granite and granulite. Enclosed 1895 when the Lap Plantation was made. The large hollow between Alt Ruidh and the Wild Cat Burn was originally planted with Scots pine which made no progress. It was drained in 1911 and the debris from the drains thickly planted with small Norway spruce. In 1919, as the pine shewed no sign of making a crop, enough spruce were transplanted to make good the whole area, about 3 acres, with spruce at 9 ft., the Scots being left as nurses. The spruce was severely checked by the move, but responded to a top dressing of slag given in 1924, and now looks like making a healthy though rather rough wood.

East of this hollow we pass on to the granite and the soil improves. There was a good growth of pine beside the Wild Cat Burn till the snow as usual intervened. A group of Sitka transplants introduced to fill a gap in 1918, have grown very fast. The tallest tree, 5 ft. 6 in., when moved measured 35 ft. by 18 in. in October, 1929. A group of Norway beside the loch is also doing well.

The Douglas on the Ruidh Burn, the first planted here, date from 1908. Unfortunately the site is exposed. In October, 1929, one of the tallest trees measured over 30 ft. by 20 in. The average annual height growth for the last ten years had been 2 ft. The plantation was thinned 1923 and more Douglas added above and below. The Omorika spruce by the path was planted 1908, 2-year seedlings on turfs. The adjoining larches, European, Japanese, and hybrid were planted 1916. The white spruces near the burn, between the path and the loch, date from about 1911.

MEALL GLASUAINE PLANTATION

At the east end of this compartment we have made a rough and ready pinetum. Near the loch is a Japanese group. Behind them and across the burn in Compartment XVIa are European and American species, and some new conifers from Eastern Asia.¹ The Nootka cypresses were raised from seed gathered at Sorn Castle, Ayrshire. Some sycamores were planted along the burn 1926 and a few survive from an earlier planting.

Above the pinetum a stretch of molinia ground was planted with larch about 1905. This ground is quite unsuitable for that tree. Some Sitka and Norway spruce have been introduced, but require to be made solid.

The ride in Compartment XVIa should be prolonged across this compartment to the Lap Burn. The area above this line needs overhauling. It is only fit for *Pinus Contorta* or Sitka spruce. The work has been begun this year.

¹ For list of Conifers see Appendix V.

MEALL GLASUAINE PLANTATION

COMPARTMENT XVII.

5.5 acres. Altitude, 1269-1285. Aspect, varied. A low hill composed of drift and mostly covered with deep peat broken into hags. Boulders and gravel along loch side. Enclosed 1897, when Lodge was built. The bank of the road behind the Lodge was planted with rowans in 1898. These have been carefully pruned. The tallest are now 30 ft. by 16 in. Birches and rowans were also planted on the loch side. Two birches beside the big stone near the fountain are natural.

In 1899 the peat hags north of the Lodge were planted with Scots pine and a few Norway spruce. Ten years later these hags were drained by Cameron, and the heather completely buried in debris from the ditches. They were planted 1909 and 1910 with Sitka and Norway spruce, and top-dressed where they hung fire with ashes from the Lodge. The Scots pine of 1898, which was nearly leafless, made an extraordinary recovery after the draining, except where the debris was so deep as to kill it. This resulted in a double crop. In May, 1916, a great part of the pine was cut out. Also the birch which was replaced by *nobilis* and Sitka. Blanks in the spruce were made up with transplants from parts where the Scots pine was intended to remain. On this black soil transplanting is easy and safe. Parts of the Sitka were thinned in 1924-26. The tallest removed in July, 1924, measured 24 ft. 2 in. by 10½ in. The largest trees in October, 1929, measured 35 to 40 ft., with a girth of over 20 in. In 1926 the wet hollows along the pony path behind the house were drained and made up with Sitka transplants.

The rowan by the big stone on the lawn was planted in 1916.

MEALL GLASUAINE PLANTATION

The oldest Cembran pines date from 1903. Others were added at intervals up to 1916. They have all been badly attacked by *Brunchorstia* and the majority have been removed. The tallest survivors on the bank above the bridge are now 20 to 25 ft. by 20 in.

A few *Betula occidentalis* from seed gathered by Dr. Henry in Vancouver in 1907 were planted out near the larder in 1913, but they have not done well.

The sycamores by the road outside the garden gate were planted in 1908 on forced ground. The tallest in 1912 measured 15 ft., and 31 ft. in 1926. Most of the sycamores in the garden were planted some years later.

The Japanese larch below the road was planted in 1905 on gravel thrown out when the road was constructed. The tallest measured 15 ft. in October, 1912. This group was not thinned early enough or hard enough. An isolated tree which had more room is by far the best in form as well as size. It measured 40 ft. by 22 in. in October, 1926, and 44 ft. by 28 in. in 1929. *Phomopsis* appeared here after the dead branches were pruned, but the scars healed up. The tops of these trees were pruned every year so long as they were within reach.

The oldest beeches in this compartment date from about 1916. Those near the bridge were planted in 1926.

The birches on the knobbie in the garden are Chinese. Forrest 22520. They were planted in 1926. The beeches were added in 1929.

MEALL GLASUAINE PLANTATION

COMPARTMENT XVIII.

5.8 acres. Altitude, 1270-1335 feet. Aspect, South-East. On the granite. Enclosed 1919 and planted 1920 with Sitka spruce on mounds with slag, and European larch on the drier ground, most of which was replaced with Sitka three years later. The knobbie at the North-East corner next the bridge has still to be planted.

MEALL GLASUAINE PLANTATION

COMPARTMENT XVIIIb.

5.8 acres. Altitude, 1300-1430 feet. Aspect, South-East. On the granite. Enclosed 1919 and planted 1920, Norway, Sitka, and Engelmann's spruce on mounds with slag, and European and Kurile larch on the dry ground. Most of the European and all the Kurile larch was replaced in 1925-6 by spruce and Japanese larch.

MEALL GLASUAINE PLANTATION

COMPARTMENT XVIIIc.

8.1 acres. Altitude, 1305-1500 feet. Aspect, South-East. On the granite. Enclosed 1919 and planted 1920 with Sitka and nobilis on mounds, and European larch on the dry ground. The Sitka was top dressed with slag after planting, the nobilis not till 1925 when its growth had become seriously checked. Most of the European larch was in 1926 replaced by Japanese.

MEALL GLASUAINE PLANTATION

COMPARTMENT XVIIIId.

12.7 acres. Altitude, 1315-1435 feet. Aspect, South-East. On the granite. Enclosed 1919. The east section planted in 1921 with Sitka, Douglas (Fraser River), and European larch. Most of the latter replaced 1926-7 by spruce and hybrid larch. Planting continued 1927 as far west as the stony ridge. Beside the bottom ride an experiment made 1927 to compare Inchnacardoch system of Side Notching with Belgian system of Turf Planting for Sitka and Norway spruce with and without basic slag. The European larch beside the Wild Cat burn were raised from seed from the old trees at Fersit. They were planted out in 1928. Planting completed 1929.

MEALL GLASUAINE PLANTATION

COMPARTMENT XVIIIIE.

8 acres. Altitude, 1429-1500 feet. Aspect, South-East. On the granite. Enclosed 1919. Deer leap constructed 1920. A small area near the gate planted in 1921 with European larch. Hybrid larch planted on stony ridge 1926-7. Completed 1928 with Sitka and Pinus Contorta, with the exception of a small area next the Wild Cat burn.

MEALL GLASUAINÉ PLANTATION

COMPARTMENT XVIII_F.

4.3 acres. Altitude, 1365-1485 feet. Aspect, South-East. On the granulite, except a narrow strip along the Wild Cat burn. Nothing yet planted except a group *on bank of burn/-* of 20 European larches, planted November, 1929—the first larches raised from seed gathered in these plantations.

The intention is to plant this Compartment and the similar ground adjoining in XVIII_D & E with *Pinus Contorta* or Mountain pine in pits on the hard ground and Sitka on turfs or mounds in the hollows. The pine to be planted at 6 ft. with a view to introducing Sitka later.

COIRE CREAGACH PLANTATION

NOTE TO COMPARTMENTS XIX.—XX.

Altitude, 1275-1430 feet. Enclosed 1902 and enlarged 1906.

The first fence struck the Coire Creagach burn at the old turbine dam. This part was planted in 1903 and 1904 with Scots pine at 4 ft., and with larch near the burn. Only the drier parts, a small portion of the whole, was planted. No draining.

In 1906 the fence was altered to include the upper water tank. This addition was not planted till 1908 and 1909.

The middle path of the Boat House Plantation is continued to the Coire Creagach burn and serves to divide these compartments.

COIRE CREAGACH PLANTATION

COMPARTMENT XIX.

24 acres. Altitude, 1275-1400 feet. Aspect, North. Soil, varies from good larch ground next the burn to deep peat. On Rannoch granite. No outcrop except in the burns.

The Scots pine of 1903-1904 had more to show for its first ten years than that in the Boat House had at the same age, but growth has been very slow. Most of the ridges were beaten up with mountain pine, 1908-1909. In 1912 all these ridges were drained. They were not wet, but it was necessary to cut through the tight peat to admit air to the soil.

The larch of 1903-4 behind the buildings was beaten up twice. The best trees in October, 1912, were 12 feet high. It was thinned 1918-19 and again in 1920, but not enough. It was attacked by chermes 1917-18 and canker followed. The chermes abated in 1919, but appeared again very severely in 1920. An average tree felled that year measured 24 ft. 8 in. by 11½ in. The cold summers and open winters of 1922-24 told severely on these trees. Many died and on others all the shoots died back. 1925 was a good summer. So was 1926, though there was a slight recurrence of chermes. The wood was heavily thinned in August, 1926. The taller trees felled were 30 ft. and over. The best of those left standing measured 40 ft. by 20 in. Blanks have at various times been made up with Sitka and Douglas and part has been underplanted with beech.

In 1905 part of the flat ground immediately to the west of the steading was properly drained and notched

COIRE CREAGACH PLANTATION

with Scots pine and some larch on the stonier parts. The Scots pine only succeeded close to the drains. It was, therefore, cross-drained and beaten up with upright mountain pine on turfs, 1908-1909. The mountain pine has grown fairly well but the place is too wet and dank for it and there has been much leaf shedding and some *Brunchorstia*. The best are now 15 ft. high. It has been cleaned and made good with Norway spruce. According to the geological map there is here alluvial soil below the peat.

A group of Norway, just below the steading, was planted in 1913 at 3 ft. It was thinned out to 6 ft. when about 6 ft. high and the result had been a vigorous growth. The height in October, 1929, averaged 17 ft.

In a hollow near the Boat House bay we made our first incorrect attempt to imitate the Belgian turf planting, as described by Dr. Henry, when he paid us a visit in September, 1905. The ground was prepared that autumn with drains 3 feet apart, the turfs being thrown on their backs between the drains so as to form "lazy beds." They were not planted till the spring of 1907, with Sitka spruce notched. In 1910 the alternate drains in the western half of this experiment were deepened and the turfs used to fill in the others. In 1911, in the other half, the alternate drains were deepened, but the debris was thrown round the plants. No manure was given at the time of planting which no doubt accounts for the poor growth. The whole was top dressed about 1922.

In 1911-12 the turf planting from Compartment V was prolonged for about 2 or 3 acres into this section with Sitka spruce—shabby plants which had been frosted in the nursery. The growth was slow, but the planting formed a useful reserve from which transplants were freely borrowed thirteen years later. One hollow which lagged behind was top dressed with slag in March, 1927.

COIRE CREAGACH PLANTATION

The group of *Pinus monticola*, beside the Coire Creagach Burn was planted about 1920, the seed being a present from Mr. R. H. Campbell of the Canadian Forestry Department.

The bulk of this compartment was overhauled in 1925 and 1926. It was a fine summer and autumn, and the work continued from midsummer till Christmas. The Scots pine was thinned and underplanted with Sitka transplants in pits. The largest unplanted flat was drained and planted with Sitka on mounds, a ride being left diagonally from east to west (see page 53). At the west or sheltered end large transplants up to 9 ft. high were employed; further east smaller transplants and beyond these ordinary nursery plants. All the transplants were borrowed from the 1911-12 turf planting. No deaths so far. The smaller transplants were top dressed in 1926. The larger not till 1928.

The lower part of this compartment has been left rather open for the sake of the view from the Lodge and road. The flat west of the Offices might be reclaimed for hay. The ground across the road was precisely similar till Cameron reclaimed it by a top dressing of ashes and some draining.

COIRE CREAGACH PLANTATION

COMPARTMENT XX.

12.6 acres. Altitude, 1345-1430 feet. Aspect, North. Soil, rather above the average. On the Rannoch granite, but no outcrop except in the burns.

The bulk of this compartment was included in the first enclosure of 1902, though much of it was not planted. The triangle added in 1906 at the south-west corner was carefully planted in 1908 and 1909, the harder ground being drained and notched with larch, the rest planted with Norway spruce and upright mountain pine on turfs. Near the Coire Creagach gate a group of white spruce.

The area of mountain pine near the gate is on very bad peat. Its growth compares very favourably with the group near the Offices (XIX). An acre of fairly good ground just above the path was planted in 1913 with *Pinus Cembra* on turfs with a view to seeing what it would do in close canopy. It was attacked by *Brunchorstia*, and Sitka transplants were substituted in 1925.

The upper part of this compartment still requires attention where Scots pine is occupying good spruce ground. Also a vacant space next the ride, part of which might be left untouched to shew the character of the ground before draining. It is a fair sample of turf planting ground over granite which is better than the corresponding type over granulite such as the quarry flat.

The larch near the tank was thinned and underplanted with Norway spruce in 1928. The adjoining larch is to be thinned and made up with *Thuya plicata* this year or next.

MEALL NATHRACH PLANTATION

NOTE ON COMPARTMENTS XXI.—XXII.

Altitude, 1275-1455 feet.

Enclosed in 1902 and enlarged 1906. The first enclosure (included in XXI) contained little ground that could be planted without draining. It was, wherever possible, planted in 1903 and 1904 with larch.

These compartments were the first in these plantations to get systematic treatment. Draining was begun in Section XXI in 1905. In 1906, when Section XXII was enclosed, the whole was drained, and in 1907 planted with larch, Scots pine, and spruce, partly by notching and partly (about 7 acres) on turfs on the Belgian system, of which this is our earliest example (see XXI). This planting was beaten up in 1908 and 1909.

An inspection path is desirable here.

MEALL NATHRACH PLANTATION.

COMPARTMENT XXI.

13.3 acres. Altitude, 1275-1320 feet. Aspect, North-West. Moraine ridges separated by hollows of deep peat over the Rannoch granite, and, lower down, some alluvial deposits.

The European larch, planted in 1903-1904, has done fairly well, and so have a few Japanese larch planted in a hollow near the cow gate 1905. The larch was heavily thinned in the autumn of 1926. Some of the Japs have been left unpruned to shew the effect of frost.

Groups of Sitka notched in 1904 on old peat cutting were kept back by frost for several years but have got away one by one. The tallest in 1929 are 30 ft. by 27 in. The adjoining trees planted at the same time on natural surface (drained) are not more than 3 to 5 ft. high.

The turf planting of 1906-1907 was, unfortunately, confined to the worst ground—the wet hollows below the cow path—and much doubtful ground which we should now plant on turfs was notched. The plants on turfs were also placed rather far apart ~~from~~ such poor soil. The first piece, planted by C.S.M., J.S.M., and Cameron, with two reliable men, had hardly any deaths. But most of the turf-planting needed a good deal of beating, owing to careless handling of the 2-year seedlings, which were the only plants employed. Following the work of various planters along the lines of turfs, the percentage of deaths was found to vary in this section from 0 per cent. to 33 per cent. for Scots pine, and from 4 per cent. to 48 per cent for spruce. Such small spruces are not easy to handle. As this experience was repeated in Compartment XII (*q.v.*) the following year we have never again

for/

up/

MEALL NATHRACH PLANTATION

employed 2-year seedlings of spruce. With careful handling 2-year seedlings of Scots pine can be safely employed. The spruce planted on turfs in this section have never yet looked very well. They have been terribly invaded by grass, another reason for using larger plants. The Scots pine, on the other hand, did extremely well for the first three years. In 1910 its growth diminished, and it became yellow. That autumn and the following spring the drains of the turf planting were deepened throughout this section. The part first treated showed a decided improvement in October, 1911. Nearly all the plants had regained their ordinary colour and growth in the autumn of 1912. The Scots pines notched at the same time, though one year older, were then less than half the size of those planted on turfs, and many had not begun to grow at all. *Molinia* ground is, however, unsuitable for pine. Trees which grew rapidly up to 8 or 10 ft. were by 1926 so poor that they had to be replaced by Sitka. Some years earlier the gaps in the pine behind Robertson's house had been made up with *Nobilis* fir and Veitch's fir.

A few *Pinus Murrayana* were planted in this compartment in 1924 where larch had failed on unsuitable ground. They have made a remarkably good growth. A plant lifted by Mr. R. L. Robinson in 1927 had roots up to 6 ft. in length. Though bought as *Murrayana*, it is possible that these plants are really *Contorta*.

MEALL NATHRACH PLANTATION

COMPARTMENT XXII.

21.3 acres. Altitude, 1300-1455 feet. Aspect, North-West. On the Rannoch granite. Morainic ridges separated by peat covered hollows. All plantable. The greater part of this compartment was not enclosed until 1906. It was drained that year, and planted in 1907 with Scots pine and larch, all notched, and larch partly notched and partly dibbled as 2-year seedlings. The larch was cleaned from time to time and first regularly thinned 1926. The taller trees in 1929 measured about 20 ft. The Scots pine has done badly despite careful draining, and in places the north wind sweeping up Strathossian has nearly killed it out. It should be replaced by Sitka. It is a case for turf nurseries as the ground is drained and large plants in pits will give the best result.

The western corner of this compartment next the burn and between the cow path and the old dam was planted in 1903. The tallest larches here measured 35 ft. in October, 1929.

An acre or so of comparatively good ground near the top was planted (1907) with Japanese larch, which was badly frosted the first year, but made a good recovery. It has been pruned at intervals, but not enough, and is very rough compared with the European larch. This is probably one of the highest pre-war plantations of Japanese larch in Scotland. The best trees are now 25 ft. high, with a girth of 18 in. The average is about 20 ft. by 12 in.

In 1907 a hollow near the fence was planted with Sitka spruce, 2-year, 1-year, badly frosted the following autumn. Mr. Dawson suggested top dressing with sand. A few rows were top dressed in the autumn of 1908 with

MEALL NATHRACH PLANTATION

sand and basic slag (seven of sand to one of slag) left over from the turf-planting. Two basketsful were given to each tree, which works out at about 3 tons of slag per acre. No change was visible the first year, but in 1910 there was a marked improvement. The top dressing was extended to other rows in 1910 with sand alone, without result. In the autumn of 1912, at the suggestion of Professor Somerville, a few more rows were top dressed with basic slag alone, at the rate of 7 cwt. to the acre. The trees top dressed in 1908 now average 27 ft. by 15 in. Those top dressed in 1912, 23 ft. by 13 in. In the control where the trees were untreated, several are dead. The tallest tree measures 10 ft., and the average is about 5 ft. A small burn crosses the control. The tallest trees grow beside it. The others growing under the same conditions as the top dressed plots are 3 to 4 ft. high. The burn skirts the other plots but does not cross them.

Above the path some experiments were made, 1906-1907, to test the comparative results of turf planting:—(a) with sand and basic slag; (b) with sand alone; and (c) without either. The place selected was unfavourable, being a bed of peat 5 feet or more deep, but there is no doubt (1912) that (a) has done best, and (b) better than (c). This tallies with Belgian experience.

The rest of this peat bed was taken in hand by Cameron's son, Alastair—an arduous holiday occupation. He drained it on his own and planted it on mounds with nobilis and Sitka. These trees, which had no slag, are still in the check stage. The planter having passed through the Beaulieu School is in the Forest Service, and in charge of plantations in Fife.

Some of the best hollows where larch has failed were made good in 1927 with Douglas. The large area of blasted Scots pine is to be replaced by Sitka grown on the spot in turf nurseries.

BIRCH CLUMPS

COMPARTMENT XXIII.

4.6 acres. Altitude, 1269-1305 feet. Flat ground exposed to West wind. Alluvium over granite, with a good deal of peat.

In 1904-1908, patches of this ground, mostly mossy, were trenched and planted with birch and rowan, with basic slag on the roots. The birches suffered severely in 1909-1910, partly, we think, from the exceptional frost and partly from the exhaustion of the manure. They were attacked when 6 to 8 feet high by a fungus which formed a swelling on the lesser branches and caused the branch beyond the swelling to die off. The disease appeared to be unknown in this country. We were advised to prune and burn the affected branches. This was done for 2 or 3 years and the worst trees removed. The rest recovered and soon not a trace of the disease could be found. It must have declined naturally, as the pruning was far from complete. *B. pubescens* suffered more than *B. verrucosa*. Only planted trees were attacked.

In 1908-1909, some of the trenched patches were sown broadcast with birch, Scots pine, and mountain pine, each in different places. Few of the seedlings have kept their hold except where there was a top dressing of ashes. All the Scots pine in this compartment, and much of the upright mountain pine, is from these sowings.

Between the Kennels and the Nursery (made in 1906) a piece of grassy ground was planted with alder about 1899. It was afterwards trimmed up and underplanted with sycamore, Norway maple, and ash, and most of the alder has since been cut out. Near the Stalker's house, where the soil is better, a clump was planted in 1909, with beech and other hardwoods. The Sitka group beside this was planted in or about 1915.

KNOBBIES PLANTATION

COMPARTMENT XXIV.

3.5 acres. Altitude, 1265-1280 feet. Aspect, open all round, but specially exposed to the north. Rocks and gravel, over granite. Some bad peat.

Enclosed, 1911-1912. The best parts planted the same season with European larch in pits.

1923-25. Hollows between larch ridges drained and planted with Sitka on mounds. Some rowans planted along the path.

1926. Two islands in river planted with white alder and sycamore respectively, and a patch of white alder near the Uisge Labhar gate.

STRATHOSSIAN PLANTATION

COMPARTMENT XXV.

2.5 acres. Altitude, 1205-1220 feet. Aspect, North-East. Good soil, brought down by burn. Old croft.

Enclosed 1909 and planted 1910 with larch, Scots pine, Sitka spruce, and a few sycamores and maples.

Much neglected. Many of the sycamores devoured by cattle. Larch made a good start, but almost wiped out by chermes during a series of cold summers and open winters. Thinned 1927. Earlier thinning might have mitigated the attack. Growth of Sitka rapid but rough.

This spring (1929) most of the larch cut out and replaced by beech. Sycamore beaten up. Gaps in Sitka made good and double tops removed. A group of *Pinus contorta* planted on turfs at highest point.

LUIB NA CLACH PLANTATION

COMPARTMENT XXVI.

1 acre. Altitude, c. 1270 feet. Aspect, North, but very open. Soil, gravel.

Enclosed and planted 1913 with European larch and a few Scots pine. No attention since.

LOCH OSSIAN PLANTATIONS

FUTURE TREATMENT

The main objects of the next few years must be:—

- (1) to tend the surviving groups of Scots pine;
- (2) to replace gaps and failures by more suitable species, while retaining all possible shelter;
- (3) to drain and plant areas not yet planted.

Generally speaking the compartments should be taken in order of merit beginning with the best. The plantations on the schist and granite should therefore be tackled first. The transition to spruce has been nearly completed in V, XVIa, XIX, and XXI, and begun elsewhere. On the schist XI, X, IX, and parts of IV and VII are the urgent cases; on the granite, XXII and the upper part of XX. For most of this work large acclimatized plants are required. We propose to raise them in turf nurseries on the spot. Turf nurseries have already been constructed for VI and VII which will determine their place in the programme.

The bulk of the experimental work has been applied to the granulite, because it was the more difficult ground. Most of the early turf planting and nearly all the pre-war spruce are on this formation in V and XII. A large extent of granulite, however, still has to be treated, the urgent cases being XVIb, XIII, and the eastern sections of XI and XVa. Where the ground has been drained turf nurseries will be the best method; elsewhere, turf or mound planting will probably prove cheaper.

The planting has still to be completed in XVIIIb and XVIIIf. Here the plants will be on turfs or mounds where draining is necessary, and elsewhere in pits, nursery plants being used in both cases.

LOCH OSSIAN PLANTATIONS

As a rule planting can be continued at Corroun right through the summer, the only break in the year's work being from the end of November till the middle of March, when the staff is reduced to a minimum on account of short days and snow storms. Several of the compartments named above have already been partly treated. Most of them contain very poor areas which it may be better to leave unplanted. Before the planting is completed other work will have to be begun, such as the thinning of the older spruce, the removal of standards where the pine has been underplanted, and the construction of rides and paths.

The growth is so irregular and shelter so important that it looks as if the felling, when the time comes, should be by groups or in very small blocks. It is to be hoped that some of the best groups will be allowed to grow on for a long rotation to show what the trees of the Pacific slope can do in Brae Lochaber above the 1200 ft. contour.

A record should be kept of the total expenditure year by year on the compartments systematically planted.

LOCH OSSIAN PLANTATIONS

APPENDIX I.

PINE LOG FOUND BELOW THE QUARRY ON THE SOUTH SIDE OF LOCH OSSIAN, 1926—ELEVATION, 1300 FT.

The stem was attached to the roots, and appeared to have fallen where it lay, about 2 ft. below the present surface in a peat bog 4 ft. deep.

Length, ...	7 ft. 6 in.
Girth at base, ...	5 ft. 2 $\frac{1}{4}$ in.
Girth, breast high (4 ft. 3 in.), ...	4 ft. 1 $\frac{1}{2}$ in.

The section at the base is oval in shape (21 in. by 17 in.), the heart being on the shorter diameter and about 7 in. from the outside at the nearest point. The annual rings are in places so close that they are difficult to count, but there seem to be at least 347. Where the heart is nearest to the outside, this works out at an average of about 50 rings to the inch. At other points of the circumference it is evident that periods of very slow growth alternated with other periods less slow. Beginning from the heart, they are as follows:—

14 years, ...	$\frac{5}{16}$ in.
63 years, ...	3 $\frac{1}{8}$ in.
60 (?) years, ...	$\frac{11}{16}$ in.
106 years, ...	2 $\frac{1}{8}$ in.
104 years, ...	4 $\frac{1}{2}$ in.

It will be seen from the above that for the slowest period the annual rings are at the rate of 87 to 1 in. One wonders whether the tree may at that stage have lost most of its crown in a storm or suffered severe defoliation. There is no indication of damage by fire, and part of the bark remains quite fresh.

LOCH OSSIAN PLANTATIONS

APPENDIX II.

TOP DRESSING EXPERIMENTS.

Quarry Flat. Compartment V. 1920-21.

Sitka spruce, 2722 to the acre, planted on the Belgian System, 1910. Trees averaged 4 ft. in height when top dressed, and had been in check for 7 years. Percentage of phosphate in basic slag not recorded, but almost certainly 30 per cent. Doses (1) to (16) given 27th December, 1920. (17) to (19) three weeks later. This experiment was accurately carried out as regards the quantities given. The plots are divided by drains, but unfortunately there are no drains between the experiments and the control. There may be and probably are differences in the quality and depth of the peat, and it is a pity the plots were not repeated so as to eliminate this factor.

(A) BASIC SLAG (High Grade) WITH SAND.

- | | | |
|-----|---|----------------------------|
| (1) | $6\frac{1}{2}$ oz. slag + $6\frac{1}{2}$ oz. sand | } = 10 cwt. slag per acre. |
| (2) | $6\frac{1}{2}$ oz. slag + 13 oz. sand | |
| (3) | $6\frac{1}{2}$ oz. slag + 26 oz. sand | |
| (4) | 13 oz. slag + 13 oz. sand | } = 20 cwt. slag per acre. |
| (5) | 13 oz. slag + 26 oz. sand | |
| (6) | 13 oz. slag + 52 oz. sand | |
| (7) | $19\frac{1}{2}$ oz. slag + $19\frac{1}{2}$ oz. sand | } = 30 cwt. slag per acre. |
| (8) | $19\frac{1}{2}$ oz. slag + 39 oz. sand | |
| (9) | $19\frac{1}{2}$ oz. slag + 78 oz. sand | |

LOCH OSSIAN PLANTATIONS

(B) HOT LIME.

- (10) $6\frac{1}{2}$ oz. hot lime = 10 cwt. per acre.
 (11) 13 oz. hot lime = 20 cwt. per acre.
 (12) $19\frac{1}{2}$ oz. hot lime = 30 cwt. per acre.

(C) GROUND LIME.

- (13) $6\frac{1}{2}$ oz. ground lime = 10 cwt. per acre.
 (14) 13 oz. ground lime = 20 cwt. per acre.
 (15) $19\frac{1}{2}$ oz. ground lime = 30 cwt. per acre.
 (16) 26 oz. ground lime = 40 cwt. per acre.

(D) BASIC SLAG WITHOUT SAND.

- (17) $6\frac{1}{2}$ oz. slag.
 (18) 13 oz. slag.
 (19) $19\frac{1}{2}$ oz. slag.

LOCH OSSIAN PLANTATIONS

APPENDIX III.

EXPERIMENTS IN TOP DRESSING AND HEATHER PULLING ON SPRUCE SUFFERING FROM PROLONGED CHECK.

xx/.

Compartments ~~XIX~~ and XIII. March, 1927.

Plot 1. Control.	} Heather untouched.
Plot 2. Basic slag (40%), 15 cwt. to the acre.	
Plot 3. Control.	} Heather pulled.
Plot 4. Basic slag, same dressing as above.	

To be repeated at least twice, each plot being separated by a drain from the next.

Compartment XIX, at N.E. corner of compartment, where ride joins path. Norway spruce planted on turfs, 1909, and top dressed in 1925 with basic slag (30%), at the rate of 1 ton to the acre. Plots repeated three times.

Compartment XIII, at S.W. corner of compartment. White spruce planted on turfs, 1909. Plots repeated four times.

Compartment XIII, near the fence. Norway spruce planted on turfs, 1918. Plots repeated twice.

Unfortunately there are a good many gaps in the crops treated, caused by roe-deer, etc.

LOCH OSSIAN PLANTATIONS

APPENDIX IV.

EXPERIMENT COMPARING INCHINACARDOCH SYSTEM OF SIDE-NOTCHING WITH BELGIAN SYSTEM OF TURF-PLANTING.

1927. XVIII^d, beside bottom ride.

Plot 1.—Norway spruce.	Side-notched.	No manure.
Plot 2.—Norway spruce.	Side-notched.	With manure.
Plot 3.—Norway spruce.	Turf-planted.	No manure.
Plot 4.—Norway spruce.	Turf-planted.	With manure.
Plot 5.—Sitka spruce.	Side-notched.	No manure.
Plot 6.—Sitka spruce.	Side-notched.	With manure.
Plot 7.—Sitka spruce.	Turf-planted.	No manure.
Plot 8.—Sitka spruce.	Turf-planted.	With manure.

LOCH OSSIAN PLANTATIONS

APPENDIX V.

LIST OF CONIFERS IN CULTIVATION AT LOCH OSSIAN, 1929.¹

- Abies amabilis.*
- „ *brachyphylla.*
- „ *Delavayi.*
- „ *cephalonica.*
- „ *Faxoniana.*
- „ *Forrestii.*
- „ *grandis.*
- „ *lasiocarpa arizonica.*
- „ *lasiocarpa subalpina.*
- „ *Lowiana.*
- „ *magnifica.*
- „ *Mariesii.*
- „ *pinsapo.*
- „ *pectinata.*
- „ *nobilis.*
- „ *numidica.*
- „ *recurvata.*
- „ *sachalinensis.*
- „ *squamata.*
- „ *Veitchii.*

¹ The nomenclature follows *Dallimore and Jackson's Handbook*, 1923.

LOCH OSSIAN PLANTATIONS

- Cedrus atlantica.*
- „ *deodara.*
- Cupressus Lawsoniana.*
- „ *nootkatensis.*
- Larix americana.*
- „ *europaea.*
- „ *europolepis.*
- „ *Kurilensis.*
- „ *leptolepis.*
- „ *occidentalis.*
- Libocedrus decurrens.*
- Picea alba.*
- „ *Albertiana.*
- „ *Albertiana conica.*
- „ *asperata.*
- „ *asperata notabilis.*
- „ *Breweriana.*
- „ *brachytyla (syn. complanata).*
- „ *Englemanni.*
- „ *excelsa.*
- „ *jezoensis.*
- „ *likiangensis (syn. purpurea).*
- „ *Morinda.*
- „ *morindoides.²*
- „ *obovata.*
- „ *omorika.*
- „ *orientalis.*
- „ *polita.*
- „ *pungens.*
- „ *sitchensis.*

² From cones gathered at Leonardslee, 1925.

LOCH OSSIAN PLANTATIONS

Pinus Banksiana.

- „ *oembra.*
- „ *contorta.*
- „ *contorta Murrayana.*
- „ *laricio.*
- „ *leucodermis.*
- „ *montana pumilio.*
- „ *montana uncinata.*
- „ *monticola.*
- „ *Peuke.*
- „ *strobis.*
- „ *sylvestris.*

Sciadopitys verticillata.

Sequoia gigantea.

Thuja dolabrata (syn. *Thuyopsis*).

- „ *occidentalis.*
- „ *plicata.*

Tsuga Albertiana (syn. *Mertensiana*).

- „ *canadensis.*
- „ *Pattoniana.*
- „ *Sieboldii.*

LOCH OSSIAN PLANTATIONS

APPENDIX VI.

AVIFAUNA OF CORROUR FOREST.

I. RESIDENT SPECIES.

1. RAVEN (*Corvus corax*). Several pairs nest at altitudes from 1300 to 2000 feet, and remain throughout the winter.
2. GREY CROW (*Corvus cornix*). Common, nesting in trees and on rocky faces. A few remain the winter.
3. HOUSE SPARROW (*Passer domesticus*). Common at the Lodge since 1910.
4. CHAFFINCH (*Fringilla coelebs*). Common in the birch wood, but only a few remain to winter.
5. LESSER REDPOLL (*Acanthis linaria*). Is abundant in the Ossian plantations and the birch wood, occurring up to 1400 feet.
6. BULLFINCH (*Pyrrhula pileata*). Is common in the Lodge garden, in the neighbouring plantations, and in the birch wood, occurring up to 1400 feet.
7. TREE CREEPER (*Certhia familiaris*). Not uncommon in the birch wood where it nests up to 1550 feet.

¹ Mr. William Eagle Clarke, I.S.O., LL.D., F.R.S.E., has kindly compiled this list from his studies made on the spot during a series of years.

LOCH OSSIAN PLANTATIONS

8. GREAT TITMOUSE (*Parus major*). Is one of the rarest of the Corrour birds. In 1917 a pair nested in the birch wood at 1500 feet.
9. COAL TITMOUSE (*Parus ater*). Is common and ranges up to the limit of trees—1600-1700 feet.
10. BLUE TITMOUSE (*Parus caeruleus*). Is common, and ranges up to the limit of trees.
11. BLACKBIRD (*Turdus merula*). Is now common in small numbers in the gardens and plantations from 1275 to 1350 feet.
12. HEDGE ACCENTOR (*Accentor modularis*). Is now, though few in numbers, a resident in the Lodge gardens and adjacent plantations at 1300 feet.
13. DIPPER (*Cinclus cinclus*). Is fairly common on the burns, rivers, and lochs up to an elevation of 1800 feet.
14. WREN (*Troglodytes troglodytes*). Is common in suitable haunts up to 1700 feet.
15. LONG-EARED OWL (*Asio otus*). A few pairs frequent the birch wood and nest up to 1700 feet.
16. TAWNY OWL (*Strix aluco*). Is not uncommon, and ranges from 1250-1750 feet, nesting in holes in old trees, or on faces of crags.
17. GOLDEN EAGLE (*Aquila chrysaetus*). Up to a few years ago, three pairs nested at altitudes at 1950, 2050, and 2420 feet.
18. PEREGRINE FALCON (*Falco peregrinus*). Two or three pairs nest on faces of crags at altitudes ranging from 1750 to 2100 feet.
19. MALLARD (*Anas boscas*). Is common, nesting from 750 to 2100 feet.
20. TRAIL (*Querquedula crecca*). A few are resident, but is also a common summer bird. Its chief resorts are the hill lochs at altitudes from 1350 to 2100 feet.

LOCH OSSIAN PLANTATIONS

21. WATERHEN (*Gallinula chloropus*). Fairly common. It nests on moorland lochs at 1350 and occasionally at a hill loch at 2060 feet. A few remain all the winter.
22. BLACK GROUSE (*Lyrurus tetrix*). Is common in the birch wood to the limit of trees at 1600-1700 feet.
23. RED GROUSE (*Lagopus scoticus*). Is numerous and nests on the moorlands up to 2250 feet. And some winter over 2000 feet.
24. PTARMIGAN (*Lagopus mutus*). Are numerous from 2000 to 3600 feet. Occasionally they are found as low as 1700 feet.

II. SUMMER VISITANTS

1. TWITE (*Acanthis flavirostris*). Is confined to low heathery ground, below 1000 feet, about Treigthead.
2. REED BUNTING (*Emberiza schænicius*). A few pairs nest on marshy ground at the foot of Loch Ossian at 1300 feet.
3. SKYLARK (*Alauda arvensis*). A few pairs nest on wild moorland ground at from 1200 to 1350 feet.
4. PIED WAGTAIL (*Motacilla lugubris*). A few pairs nest on the margins of Loch Ossian (1270 feet), and occasionally at Loch na Lap at 1940 feet.
5. GREY WAGTAIL (*Motacilla boarula*). A few nest on the margins of Loch Treig at 800 feet, and on its tributary streams to about 1000 feet.
6. TREE PIPIT (*Anthus trivialis*). Is fairly common in the Ossian woods up to 1550 feet.
7. MEADOW PIPIT (*Anthus pratensis*). Common, nesting from 700 feet to the summit of Beinn Eibhinn (3611 feet).

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8. LESSER WHITETHROAT (*Sylvia curruca*). A waif in full song at the head of Loch Treig on June 13th, 1915.
9. WILLOW WARBLER (*Phylloscopus trochilus*). Is abundant in the Ossian birch wood from 1600 to 1700 feet, and in plantations on the side of the Loch (1269 feet).
10. WOOD WARBLER (*Phylloscopus sibilatrix*). A few nest in the old wood on the side of Loch Ossian at 1350 to 1550 feet—probably its highest nesting range in the British Isles.
11. SONG THRUSH (*Turdus musicus*). A few nest in the plantations and the garden on the margins of Loch Ossian at 1350 feet, and at lower elevations at the head of Loch Treig.
12. RING OUZEL (*Turdus torquatus*). Nests fairly abundantly on rocky ground, heathery slopes, and steep burn sides; at altitudes ranging from 1000 to 3000 feet.
13. REDSTART (*Phœnicurus phœnicurus*). Is common in the Loch Ossian birch wood, where it nests up to 1630 feet.
14. REDBREAST (*Erithacus rubecula*). A few pass the winter in the Lodge and other gardens. It is, however, commoner as a summer visitor or where it ranges up to 1600 feet.
15. STONECHAT (*Saxicola rubicola*). A pair summer at 1000 feet at Loch Treig head.
16. WHINCHAT (*Saxicola rubetra*). A few summer on rough grassy ground, where whins flourish, at from 800 to 1350 feet.
17. WHEATEAR (*Enanthe ænanthe*). Common on the moorland and stoney tops, and nests up to 3100 feet.

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18. SPOTTED FLYCATCHER (*Muscicapa grisola*). Not uncommon in the birch wood up to 1400 feet.
19. CUCKOO (*Cuculus canorus*). Common and occurs up to 1600 feet.
20. KESTREL (*Falco tinnunculus*). Common, nesting on rocky faces at elevations as high as 2000 feet.
21. SPARROWHAWK (*Accipiter nisus*). A pair nest in the birch wood at from 1500 to 1600 feet.
22. RED-BREASTED MERGANSER (*Mergus serrator*). A pair nest annually at the head of Loch Treig.
23. WOODCOCK (*Scolopax rusticola*). One or two pairs nest in the birch wood at 1300 to 1600 feet.
24. SNIFE (*Gallinago gallinago*). Nests on the moist moorlands, where it is sparsely distributed from 800 to 1350 feet.
25. DUNLIN (*Tringa alpina*). A few pairs nest on flat wet moorland ground at 1350 feet; and at 1100 feet on the moor bordering the Blackwater.
26. GREENSHANK (*Totanus nebularius*). A few pairs nest on moist, grassy, moorland ground at from 1100 to 1350 feet.
27. COMMON SANDPIPER (*Totanus hypoleucus*). Common on the margins of streams and lochs, where its nests from 790 at Loch Treig to 1940 at Loch na Lap.
28. CURLEW (*Numenius arquata*). Abundant on grassy moorland ground where it nests from 1000 to 1300 feet; and also on mountain slopes up to 2500 feet.
29. GOLDEN PLOVER (*Charadrius apricarius*). A few pairs nest on one or two dry mossy plateaux at 2700 and 3000 feet.

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30. LAPWING (*Vanellus vanellus*). Is a scarce native of the Forest. A pair or two nest on rough grass-land at the foot of Loch Ossian at 1300 feet, and a pair nest on the moor bordering the Blackwater at 1100 feet.
31. BLACK-THROATED DIVER (*Colymbus arcticus*). This is one of the scarcest birds nesting in the Forest, where it nests on hill lochs at 1300 to 2000 feet.
32. LITTLE GREBE (*Podiceps fluviatilis*). A pair nested in 1917 on a moorland loch at 1350 feet.

III. WINTER VISITANTS.

1. SNOW BUNTING (*Plectrophenax nivalis*). Common and may possibly nest in mountains of the Forest. In winter it has been observed in numbers at 3000 feet.
2. FIELDFARE (*Turdus pilaris*). Numbers appear and frequent heathery ground at the foot of Loch Ossian (1300 feet), but depart in the advent of severe weather.

IV. OCCASIONAL VISITANTS.

1. STARLING (*Sturnus vulgaris*). Is only to be regarded as an irregular visitor. During winter and spring a few have been observed at the foot of Loch Ossian on a few occasions.
2. GREENFINCH (*Chloris chloris*). A male appeared on the 4th of December, 1915—the only known occurrence of this species in the Forest.
3. MERLIN (*Falco æsalon*). Is a rare visitor to the wild moorland ground at 1150 feet.
4. CORMORANT (*Phalacrocorax carbo*). Occasionally visits to Lochs Ossian and Treig.

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5. GOOSANDER (*Mergus merganser*). An adult male appeared on Loch Ossian on December 3rd, 1915.
6. REDSHANK (*Totanus totanus*). As a casual visitor it has appeared on several occasions in June.
7. OYSTERCATCHER (*Hæmatopus ostralegus*). Appears irregularly on its spring and autumn migrations at Loch Treig and Loch Ossian.

Though no species of Gull has been known to nest in the Forest, yet a few Blackheaded Gulls (*Larus ridibundus*), the Lesser Black-backed Gull (*Larus fuscus*), the Herring Gull (*Larus argentatus*), and Common Gull (*Larus canus*) visit the moorlands and lochs in summer.

In June the Swallow (*Hirundo rustica*) and the Swift (*Micropus apus*) occasionally visit the Forest, but soon pass on.

Since the above list was compiled the following birds have nested at Loch Ossian:—

HERON (*Ardea cinerea*).
SEdge WARBLER (*Acrocephalus phragmitis*).
GOLDCREST (*Regulus cristatus*).
COMMON GULL (*Larus canus*).
STARLING (*Sturnus vulgaris*).

Also probably:—

GREY WAGTAIL (*Motacilla melanope*).

The following have been observed:—

REDWING (*Turdus iliacus*).
JACKDAW (*Corvus monedula*).
WHOOPEr SWAN (*Cygnus musicus*).
CARRION CROW (*Corvus corone*).
ROOK (*Corvus frugilegus*).
CORMORANT (*Phalacrocorax carbo*).

