The effect of 19th Century Stone Drains on the growth of Sitka Spruce

By M. J. CONRY[1]

SUMMARY

In Rossmore Forest, Co. Laois, poor tree growth occurred on blanket peat planted in 1952 while there was excellent tree growth on the poorly drained gley soils of the Castlecomer Series. Within the poor stand parallel lines of relatively good tree growth occurred above stone drains installed in 1880. As a result of man's influence the depth of peat is considerably reduced in the immediate vicinity of the drains and roots pentrate to the base of the drains. Concentric ochreous mottles (neoferrans) have developed around these root channels. The drains are largely ineffective as a drainage system although the individual drains are still running.

INTRODUCTION

Rossmore Forest, Co. Laois, surrounding the "new" colliery (Fig. 1) was planted in 1952. Preliminary examination in 1970 indicated a wide variation in the growth rate of Sitka Spruce *(Picea sitchensis)*. An excellent stand of spruce had resulted on the poorly drained Castlecomer Series (around Profile 3) but in one area (around Profiles 1 and 2) growth was particularly poor. Further examination revealed that within this poor area there were parallel lines of fairly good spruce trees. Three profile pits were opened: Profile 1 one one of the "ridges" of better growth in the poor area, Profile 2 approximately midway between two "ridges" and Profile 3 in the high yielding stand. These investigations showed that: (1) The fast-growing stand was planted on the poorly drained Castlecomer Series (Surface-water Gley). (2) The poor stand of spruce was planted on a 50 cm. layer of blanket peat. (3) The fairly good parallel rows of trees within the latter area were situated above old stone drains placed in the underlying dense, tenaceous glacial till and the height of tree tapered away quickly on both sides of the drain (Fig. 5). (4) The stone drains were still carrying water.

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1. An Foras Taluntais, Oak Park, Carlow.

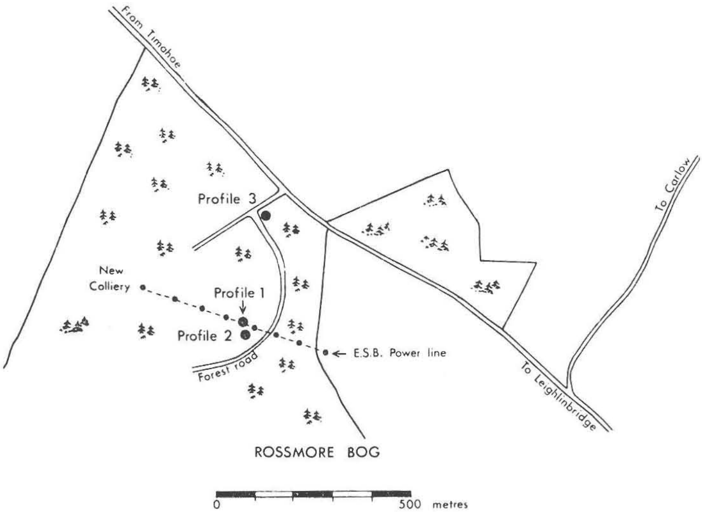

Figure 1

Location of soil profiles.

TABLE I — PROFILE ANALYSIS

Profile	Horizon	Clay	Silt	Fine Sand	Coarse Sand	pH	T.E.B.°	C.E.C.°	"Free" Iron %	C %	N %
1	021	—	—	—	—	4.0	7.4	84.8	0.2	27.4	1.2
	022	—	—	—	—	3.8	6.2	81.6	0.1	22.0	1.2
	A2g	16	44	24	16	4.3	1.7	23.4	0.1	3.2	0.19
	Btg	31	45	15	9	4.8	6.9	19.4	0.7	1.0	0.10
	Cg	31	48	12	9	7.5	9.2	7.9	1.6	0.4	—
2	021	—	—	—	—	3.7	11.5	87.2	0.1	28.0	1.4
	022	—	—	—	—	3.8	7.5	60.0	0.1	21.4	1.5
	A2g	15	45	25	15	4.2	1.2	20.8	0.1	2.4	0.14
	Btg	29	43	17	11	4.8	6.8	10.8	0.5	1.0	0.10
	Cg	28	49	14	9	5.8	4.8	15.3	0.7	0.5	—
3	A1	—	—	—	—	4.9	14.4	55.6	3.7	11.0	0.8
	A2g	29	44	18	9	6.9	15.1	16.0	1.0	1.1	0.14
	B2tg	28	43	18	11	6.9	15.4	16.8	3.6	0.5	—
	Cg	30	44	15	11	7.7	17.5	13.0	2.0	0.5	—

°T.E.B. = Total exchangeable bases (Meq/100g.)
°C.E.C. = Cation exchange capacity (Meq/100g.)

Three profiles were described, sampled and analysed (Fig. 1). Profile 1 and 2 occur in an area covered by blanket peat; Profile 1 exposed a stone drain (Fig. 2), and was situated on a band of fairly good trees while Profile 2 (Fig. 3) was sited midway between the stone drains. Profile 3 is typical of the Castlecomer Series. Profiles are described in the Appendix and analyses for the three profiles are given in Table 1. Thin sections of the mineral horizons were prepared following Laruelle's (1965) method.

The purpose of the present paper is to: (i) record the soil changes directly attributable to artificial drainage and (ii) to measure the effect of the drains on tree growth and their effectiveness for drainage purposes. During the course of the investigation the date of installation of the stone drains was also established.

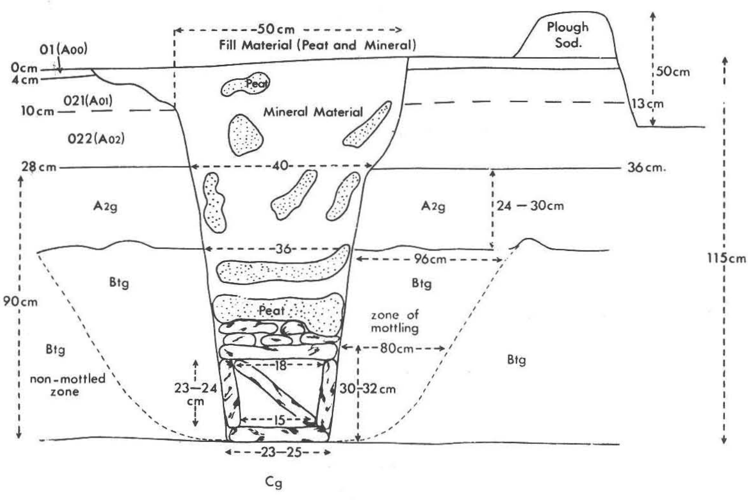

Figure 2

Diagrammatic representation of profile 1 showing field drain.

MATERIALS AND METHODS

Rossmore Forest occurs on the highest portions (up to 325 m) of the Castlecomer Plateau and has an annual rainfall of approximately 1,000 mm. The basic rock formations consist of Carboniferous shales, flagstones and sandstones with some coal-bearing seams. The region was glaciated during the Saale glaciation, but was not covered by the more recent Weichsel glaciation.

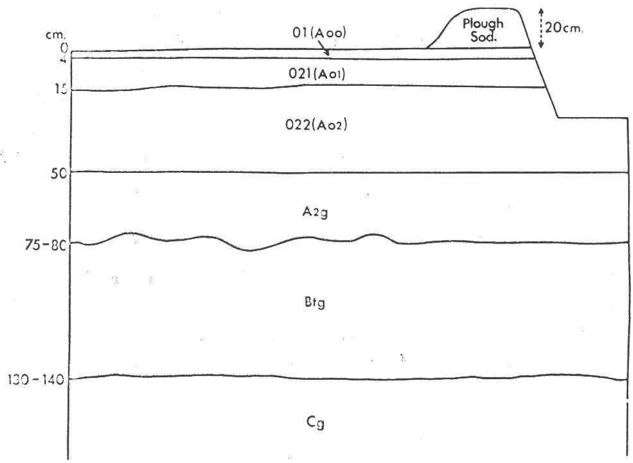

Figure 3

Diagrammatic representation of profile 2.

However, during this period solifluction phenomena denuded the steep slopes of their glacial deposits. For this reason poorly drained and very poorly drained surface-water Gleys, derived from dense, tenaceous glacial till composed mainly of shales, sandstone and flagstones are found mainly in depressional areas and on weak slopes. Extensive areas of blanket peat occur mainly in the depressions and on the gently undulating slopes.

DISCUSSION

Effectiveness of the drainage system

Although water flows freely through the drains, their effectiveness as a drainage system is extremely limited. Improved tree growth only occurs for about 1 to 2 metres on each side of the drain. Tree growth drops rapidly from the centre of the drain (Fig. 4). Dr. N. O'Carroll (Private Communication) calculated in 1971 that the tree growth over the drains had a General Yield Class of 10 (Equivalent to Yield Class 140/160 Hoppus). This compares rather unfavourably with the General Yield Class of 18 (Yield Class 200 Hoppus) on the Castlecomer Series at Profile 3 (Fig. 1). The tree growth between the stone drains was too low to be given a yield class rating.

It is obvious that the drainage scheme is only partially effective. The major defect is that the drains are too widely spaced. It is extremely doubtful if any drainage could be economically feasible on this particular situation. Apart from the excessive moisture regime in the soil, nutrition is probably the important limiting factor on the blanket peat. Ground rock phosphate application

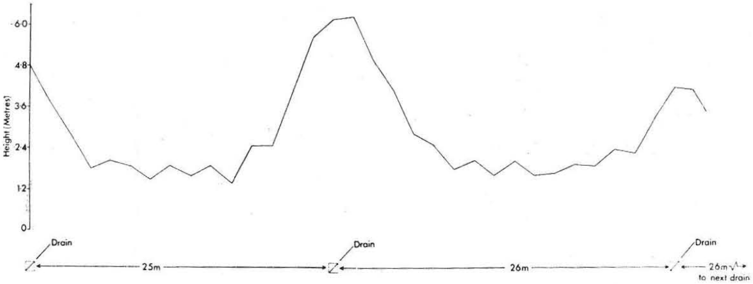

Figure 4

Mean tree height (based on 10 trees per line) in 1971, showing bands of relatively good growth in poorly growing Sitka spruce on blanket peat (Rossmore Forest).

in 1970 shows considerable growth improvement even on the poor stands between the drains where drainage is ineffective. Best results on this blanket peat can therefore be attained by ploughing to a depth of 30-40 cm. and the addition of fertilisers.

Profile changes

As a result of the installation of artificial drains in the 19th century a number of morphological changes have occurred in the soil profile. Firstly, comparison of profiles 1 and 2 shows that the depth of peat has decreased to almost half its original depth. Secondly, rooting depth has increased; in the undrained soil (profile 2) root development is largely confined to the surface peat and A2g horizon. On the other hand, tree and other roots penetrate down to the bottom of the stone drain in profile 1. Thirdly, concentric ochre (7.5 YR $\frac{5}{8}$) mottles have developed around these root channels in the gleyed (textural) B (Btg) horizon. These ochre mottles are typical neoferrans (Brewer, 1964) and occur in the mottled zone shown in figure 2. They have developed since 1880, as a result of the improved air/moisture ratio in that part of the soil.

Date of installation

It proved difficult to establish exactly when the stone drains were installed. The record of the Forest and Wildlife Service, Department of Lands, stated that the land was drained by the former landlord Adair. It was then established through the records of the Valuation Office that John George Adair owned the lands between 1864 and 1886. Further work eventually established (Conry, 1973) that the drains were installed as a Famine Relief Scheme by the Office of Public Works for Mr. Adair in 1880.

Identical drainage schemes were carried out at that same time on similar coal measure soils by the Office of Public Works, on many farms around Abbeyfeale (J. O'Connor, private communication). It seems, therefore, that a rather uniform type of stone drainage system was installed throughout Ireland at least on these heavy wet coal measure shale soils (Soil 13; Soil Map of Ireland, 1969) to relieve the distress caused by the 1879 famine (Doyle, 1971).

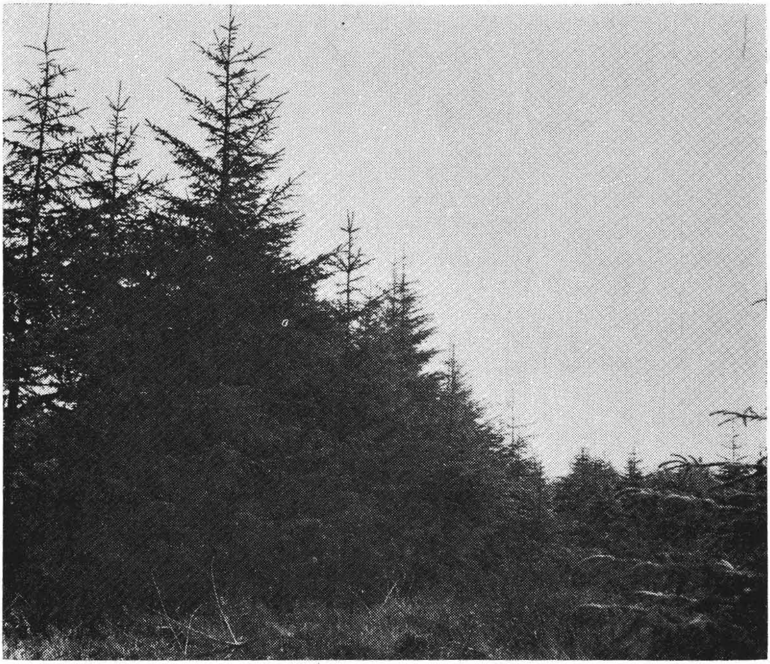

Figure 5

Relatively good tree growth over drain and poor tree growth between drains.

ACKNOWLEDGEMENTS

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Appendix

Profile 1

Location:	Rossmore Forest, Co. Laois; 37/1 T14-15
Topography:	Undulating plateau
Slope:	3°
Altitude:	325 m.
Precipitation:	1,000 mm.
Drainage Class:	Very poorly drained (now artificially drained)
Parent Material:	Dense, tenaceous, non-calcareous glacial till (Saale Age) composed of Carboniferous shale, sandstone and flagstone.
Vegetation:	Sitka spruce (*Picea sitchensis*) and occasional *Contorta pine*, with ground vegetation of mosses, *Calluna* and *Vaccinium*.
Classification:	Blanket peat

Horizon	*Depth* (*cm*)	*Thickness* (*cm*)	*Description*
01 (Aoo)	0-2½/4	2½-4	Partly decomposed plant remains
021 (Ao1)	2½-20/13	7.5-10	Dark reddish brown (5YR3/2) peat; clear boundary to:
022	10-28/36	18-23	Black to dark reddish brown (5YR2/1-2/2) peat; more humified than 021; abrupt boundary to:

A2g	28-50/66	24-30	Loam to silt loam; greyish brown (10YR5/2) with abundant blackish streaks of decomposed roots; structure-less; moist/wet plastic; gradual boundary to:
Btg	50-120/130	55-65	Clay loam to silty clay loam; bluish grey (7.5YR5/0 nearest) with faint olive brown mottles; abundant prominent strong brown mottles (neoferrans) (7.5YR5/8) along old root channels; structureless; wet plastic; gradual boundary to:
Cg	120+	—	Stony clay loam similar to above horizon except that strong brown mottles along old root channels are absent.

Profile 2

Rossmore

Location: Forest, Co. Laois; 37/1 T14-15

Topography: Undulating plateau
Slope: 2-3°
Altitude: 325 m.
Precipitation: 1,000 mm.
Drainage Class: Very poorly drained
Parent Material: Similar to profile 1
Vegetation: Similar to profile 1
Classification: Blanket peat

Horizon	*Depth (cm)*	*Thickness (cm)*	*Description*
01 (Aoo)	0-2½/4	2½-4	Partly decomposed plant remains
021 (Ao1)	2½-15	12½	Dark reddish brown wet peat (5YR3/2); clear boundary to:
022	15-50	36	Black to dark reddish brown (5YR2/1-2/2) wet peat; more humified than 021; abrupt boundary to:
A2g	50-75/80	23-30	Similar to A2g of profile 1
Btg	75-130/140	55-60	Similar to Btg of profile 1 except that strong brown mottles (7.5YR5/8) along root channels do not occur.
Cg	130+		Similar to Cg of profile 1

Profile 3

Location:	Rossmore Forest, Co. Laois; 37/1 R14-15
Topography.	Undulating plateau
Slope:	2-4°
Altitude:	320 m.
Precipitation:	1,000 mm.
Drainage Class:	Poorly drained
Parent Material:	Similar to profile 1
Vegetation:	Dense stand of Sitka spruce
Classification:	Surface-water Gley (Castlecomer Series)

Horizon	*Depth* (*cm*)	*Thickness* (*cm*)	*Description*
01	0-1/2½	1-2½	Pine needles, abrupt boundary to:
A1	1-14/15	13-14	Clay loam; dark greyish brown (10YR4/2); moderate fine to medium granular structure friable when dry and sticky when wet; root concentration in this horizon; clear smooth boundary to:
A2g	14-28/30	14-16	Clay loam; olive grey (5Y5/2) with many fine distinct mottles (10YR5/6) particularly around root channels; coarse prismatic structure, wet plastic; sparse roots; gradual smooth boundary to:
B2tg	28-85	57	Clay loam; speckled grey (5Y5/1) and yellowish brown (10YR5/6); coarse prismatic to structureless; wet plastic; sparse roots; gradual boundary to:
Cg	85+	—	Stony clay loam; grey (7.5YR5/0) with abundant distinct yellowish brown (10YR5/4) mottles; structureless; wet plastic; no roots; weakly calcareous.