PROJECT 90

R E P O R T   O N   S O I L   C H A N G E S
A S S O C I A T E D   W I T H   I N V A S I O N   B Y
B I R C H   O N   H E A T H E R   M O O R L A N D

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CONTENTS

1. INTRODUCTION

(a) Origins of the study

Over a period of many years, birch has gained a reputation for improvement of poor soils. Gardiner (1968) reviews the literature on this subject but there is little detailed descriptive pedological material published to illustrate the changes. Dimbleby (1952 a and b, 1953) relates how well developed podzols on the North York Moors have been improved to brown forest soils. Again, the pedological information given is limited, but the main trend away from a podzol profile, including softening of the iron pan and change from mor to mull humus, is striking.

As part of a major study by John Miles to investigate this theory of soil amelioration by birch, detailed pedological observations were sought. This report is the result of several weeks field-work spent studying soil profiles at four sites in Scotland and England. It aims to confirm whether or not, at these sites, birch can be thought of as fulfilling this role.

(b) Hypothesis to be tested

The hypothesis is that colonization by birch of heather moorland sites with podzolised soils improves or ameliorates these soils and regenerates a brown forest soil with mull humus. This necessitates removal of those features characterising the podzol profile - mor humus, leached horizon, iron pan etc. - and their replacement by mull humus and some homogeneous mineral material.

(c) Basic problems

Problems of terminology are frequent in discussion of soil types due to the large number of soil classification schemes. Nomenclature for upland sites is confused but for the purposes of this report the term Peaty Podzol (or Peaty Gleyed Podzol) will be used to describe the heather moorland podzol soils. The name Brown Forest Soil will be used for the Scottish sites, and Brown Podzolic for the English site, to describe the upland brown soils noted. These are different names for the same soil (Ball and

Ragg, 1960), but are used to conform with different current classification schemes in Scotland and England. Ball (1966) describes the brown podzolic group of upland soils as follows:- "A group of freely drained soils, transitional in morphology and distribution between lowland Brown Earths and mountain Peaty Podzols, occur widely in Britain, especially on steep slopes in zones otherwise dominated either by Brown Earths or by Peaty Podzols. They also occur as the dominant freely drained soil, on a wide range of slope, in a geographic zone between the Brown Earth and Peaty Podzol zones, for example in the Lake District, S. Scotland and Wales". They are more productive in agriculture than adjacent mountain and moorland soils, and are important forest soils.

It is evident that there is an accepted geographic distribution of peaty podzol and brown forest soil types. Altitude and slope, together with their influence on rainfall, temperature, run-off etc., are implied as being causes of the differentiation of these soils and their distribution, although vegetation is not dismissed entirely. Muir (1935) referred to Scottish steep slope soils of Brown Podzolic character (which are currently considered as brown forest soil in the current Scottish classification) as "creep" soils. Muir and Fraser (1940) associated these creep soils with moderate to steep slopes and with a vegetation of dry birch wood, grass heath and frequently with scrub and heaths. They explained the lack of podzolisation to soil creep and considerable lateral movement of moisture and possibly fine soil particles. Peaty podzolised soils were associated with excessive surface moisture, requiring flat or gently sloping conditions, and Calluna or Vaccinium heath. However, these authors also consider that vegetation may have influenced the present Brown Earth soils:- "It is possible in some of the Brown Earth areas that grazing and the occurrence of scrub, e.g. gorse, rowan, or even birch, has had something to do with the soil remaining in this stage and not podzolising".

The 1973-74 Macaulay Annual Report refers to Sheet 75 (Tomintoul) and claims that brown forest soils occur in the Strichen, Foudland, Countesswells and Boyndie Associations and are most frequent along the valley sides of the Strath Avon where it is probable that, despite the absence of cultivation, the effects of birchwood cover and steep slope and possibly enrichment of the soil from limestone outcrops, have retarded podzolisation. If an area had remained under birch wood continuously, one might expect a non-podzolised brown forest soil to exist. It is generally accepted that present podzolised soils have formed under heath land since forest removal during the Bronze Age (?).

However, in the study to be reported here, we are assuming (and there is a fair amount of historical proof) that the sites investigated were entirely under heather at one time. Muir and Fraser (op. cit.) claim that creep soils in Clashindarroch Forest occurring on south-facing slopes normally have a dry *Calluna* heath vegetation with a few examples of dry grassy heath. On north-facing slopes, moist *Calluna* heath occurs but there is an accumulation of surface raw humus. This evidence suggests that brown forest soils may exist on slopes under heath vegetation.

The Macaulay Report for 1972-73, in describing progress on the soil survey of Sheet 109 (Auchentoul) and 115 (Reay), notes that in the Strath Naver district the soils are mainly of the Strichen Association - peaty podzols and peaty gleys are commonly mapped in complexes with peat and rock, although brown forest soils have been delimited on some steeper slopes.

Glentworth and Muir (1963) refer to heath and moorland vegetation associated with peaty podzols or iron podzols in an area covering much of north-east Scotland. Brown forest soils may carry deciduous trees, mainly birch, or an acid grassland. In England, Kellie (1976) associates brown podzolic soils on the North York Moors with moderate slopes, and stagnopodzols (= Peaty Podzols) with plateaux, although the latter are also found on slopes.

From these and other publications, it becomes clear that an accepted widespread catenary sequence of soils and associated vegetation exists from valley floor and sides up to moorland in several parts of Britain. Brown earths and gleys under agricultural use on the valley floors give way to brown forest soils with birch woodland or acid grassland on valley sides, followed by heather moorland at greater altitude.

Observations on the soils of the selected sites should do more than confirm that peaty podzols and brown forest soils are associated with heather moorland and birch woodland respectively. It must be shown that there is a gradual alteration of identifiable peaty podzol features under increasing ages of birch wood.

2. SITES AND METHODS

(a) Factors affecting site selection

Ideally, experimental sites should be chosen in which the vegetation alone has influenced and/or is influencing the nature and distribution of the soil type or types. If time were of no consequence then a site with uniform podzol soil and dominant *Calluna* could be monitored over a period of up to 100 years as birch invaded. Any trend towards regeneration of a brown soil (brown forest, brown podzolic soil) would be recorded. This is obviously not practicable. The alternative is to use a site displaying several age classes of birch together with open uninvaded *Calluna* land. This allows soils to be investigated at a variety of times after colonization by birch. The problem with this approach is that three assumptions need to be made:-

(i) that the whole site was originally *Calluna* land, or land similar to that used as the uninvaded age class in the comparison;

(ii) that the soil over the whole site was originally uniform;

(iii) that soil-forming factors have been consistent since invasion over the whole site, apart from any vegetational influence.

Various pieces of evidence suggest that the sites chosen for the study were originally heather. However, soils were possibly not uniform originally and soil-forming factors, at least for two of the four sites studied, may not be consistent. The nature of the original soils and the action of the soil-forming factors, both before and since invasion by birch, are of course intimately linked, the first being the result of the second. The degree of influence by each of these factors - climate, relief, parent material, organisms and time (Jenny, 1941), is obviously important in deciding the soils of the sites before and since birch invasion. An attempt will be made to infer whether the soils were uniform from a knowledge of these factors and their effects on the experimental sites and from similar areas with published soil information.

(b) Description of sites

Detailed pedological studies of four sites were undertaken in the early autumn of 1975. All ages of birch are 1975 datings, and figures for altitude and rainfall are approximate or estimates. Detailed observations on the nature of the stones from soil samples at each site are tabulated as appendices.

(i) Delnalyne NJ 189 175

Adjacent heather and twenty-year old birch occur on a moderate west-facing slope at an altitude of 430 metres near Tomintoul in the NE end of the Cairngorms. The two age classes are very close on a fairly uniform slope, so climate and relief will be the same. Geological maps show Middle Old Red Sandstone or Dalradian graphite schist and slate as the underlying formations here. Soil investigations showed that as far as soil profiles are concerned, drift composed of schist, sandstone, quartzite and quartz stones in a reddish micaceous matrix covers the solid formations. The drift is quite heavily textured and dominantly dark reddish-brown in colour, undoubtedly the influence of the incorporated red sandstone and possible underlying Old Red Sandstone. Appendix A shows the major stone types from two depths from each of the eighteen main soil pits, together with those from nine smaller pits located elsewhere in the heather area. Although minor variations occur, the nature of the stones in the soils of the heather and twenty year birch age classes can be considered as very similar and not contributing to any soil differences between these age classes. However, the matrix of the drift is sandy over clayey under heather, and clayey throughout under birch and this may have influenced the soils now seen at this site.

The Soil Survey of Scotland is at present working on Sheet 75 (Tomintoul), according to the Macaulay Annual Report for 1974-75. Soils formed in Old Red Sandstone sediments and derived drifts have been named as the Tomintoul Association and this may include the Delnalyne soils. This Association is claimed to have a higher proportion of poorly drained gleys and peaty gleys than other local soil associations due to finer textures at depth. This fits with observations at Delnalyne as the soils are predominantly poorly drained.

(ii) Tulchan NJ 154 373

This site occupies moderate and steep south-east facing slopes overlooking the Spey Valley north-east of Grantown. Eighteen, twenty-six, thirty-eight, ninety year birch, together with heather, provide five distinct zones. The oldest birch occurs on steep valley side slopes at about 215 m altitude. The younger birch stands are found in sequence uphill, with the youngest birch and heather at about 275 m on fairly gentle slopes on the moorland edge.

Geological maps show the solid geology of the Tulchan area to be Moine quartzone felspathic schist. No solid formations were seen in the immediate area to confirm this. A thick cover of till containing large boulders blanket the site, even on the steep slopes. This drift contains a variety of rock types (see Appendix B) but angular fragments of quartzite are dominant. Large boulders of quartzite, schist and sandstone are found in the soils over the whole area, especially at high levels where they are often on the surface or partially buried in soil. Appendix B shows the nature of stones from all horizons in the 45 soil pits excavated. Visual examination of this data indicates no substantial variation in the nature of the drift stone content through the site. (Mineralogical evidence to be provided by Aldyth Hatton will suggest some differences in the nature of the drift matrix, however.) For the purposes of this report, the parent materials of all age classes will be considered uniform.

Soil Survey sheets 75 (Tomintoul) and 85 (Rothes) which will eventually cover the area have not, as yet, been published and other soil information is scarce. Also, the mixture of quartzite and schist etc. in the drift makes allocation of the Tulchan soils to established Scottish soil associations difficult. The

Strichen Association formed in till derived from acid schists and schistose grits, and the Durnhill Association formed in till derived from quartzite and quartz schist are the main contenders. The Foudland Association with a parent material of fine-grained schists and their derived drifts may also apply. However, Heslop and Brown (1969) have found that brown forest soils (which are found on the steep slopes at Tulchan) are absent from the Durnhill Association due to the very acid nature of its parent material and so this Association may be ruled out.

The range of altitude, variation in slope and consequent climatic differences are not great, but may be sufficient either alone or through their influence on the vegetation and land-use to allow different soils to develop within the experimental layout.

(iii) Kerrow

The Kerrow site is located on the north to north-west facing upper valley side at the lower end of Glen Affric near Cannich. Heather, seventeen, twenty-six and sixty-nine year old birch stands occur at an altitude of about 140 m, the oldest birch at the lowest point and in general on the steepest slopes on the rather irregular valley side profile. The younger birch stands and the heather occur in order of decreasing age upslope, but not necessarily on less steep slopes, and there is a fair amount of lateral spread of the plots across the valley side to coincide with the irregular scatter of the different stands. Although not obvious from the results to be shown later, the experimental site is found at a break of slope from the steeper valley sides to the gentler slopes of the moorland edge.

Geological maps show Precambrian "Undifferentiated Moine Schist" as the solid formation at Kerrow. Phemister (1960) describes the Moine Schists as consisting "predominantly of quartzo-feldspathic granulites and mica schists, and include as subordinate members calcsilicate granulites and a very few crystalline limestones. Over its whole outcrop the Series presents a banded aspect owing to the alternation of more quartzo-feldspathic with more micaceous layers". Investigation of some of the rock outcrops and solid rock material in soil pit bottoms confirmed that a dark, massive mica schist is present as far as can be judged, over the whole experimental area.

Drift forms a thin veneer over the schist, but deeper pockets occur. The drift within soil profile depth is composed mainly of schist, but of a colour different to the bedrock (see Appendix C). This limited evidence of the nature of the stones suggests that the drift is fairly uniform.

The Soil Survey of Scotland claims to be surveying Sheet 83 (see Macaulay Annual Report for 1974-75) but details of the soils have not yet been published. However, several Soil Survey publications describe the Strichen Association of soils formed in till derived from acid schists and schistose grits. It is likely that the Kerrow soils would fit into this Association.

(iv) Silpho

This site was used by Dimbleby (1952) for his study of soil regeneration under birch and is located on a plateau area at the south-eastern corner of the Cleveland Hills (North York Moors National Park) near Scarborough. The Corallian Series of the Upper Jurassic comprising a sequence of grits and oolitic limestone beds crops out locally. The beds dip gently southwards and the Lower Calcareous Grit, especially, forms fairly extensive gently sloping plateaux (the Tabular Hills) dissected by deep steep-sided valleys. Large areas of the plateaux are floored by uniform geological formations. The Silpho site is split between two areas roughly 1 km apart, but on the same plateau. Relief and climate are to be considered as uniform over the whole site. The Lower Calcareous Grit, despite its name, is a mainly non-calcareous hard, buff coloured, siliceous gritstone. Drift is not extensive, the only evidence for its presence in the Silpho soils being occasional quartz and quartzite pebbles (see Appendix D) together with a hint of silty loess in the top-soils.

The Forestry Commission, who presumably own the Silpho site and have possibly allowed the birchwoods to remain in part for amenity reasons, have surveyed the soils of Wykeham Forest (which includes Silpho) at 6" to 1 mile scale. The soil map shows "Ironpan soils" and dominating this area, although brown earths are also present locally especially on slopes. The Forestry Commission soil classification scheme (Toleman, 1975) defines an Iron pan soil as having the following:- "Thick peaty surface horizon, up to 45 cm. Greyish gleyed Eg horizon over a thin ironpan on Bf horizon. Bright brown B or Bs horizon, normally friable and freely drained. Where the ironpan is weak, the upper B may be gley mottled." This description fits with many of the soils observed at Silpho, and fits in with the Stagnopodzols Group of the England and Wales Soil Survey classification (Avery, 1973) and peaty gleyed podzols of traditional classifications.

The Soil Survey of England and Wales have ampped soils at 2½" to 1 mile scale of a 10 x 10 km square - the Troutsdale sheet, adjacent to Silpho (Bendelow and Carroll, 1976). A number of different stagnopodzols are mapped from this area on similar geological formations and the Hambleton Series gently sloping phase as described probably includes the Silpho soils. This Series, first named by Anderson (1958), is described as a loamy-skeletal textured ironpan stagnopodzol formed in Jurassic sandstone (or grit) and associated drift. Drainage is regarded as imperfect above the pan but free below. The ironpan is often weakly developed, and the subsoil is often firm, strongly cemented or indurated.

Brown earth and brown podzolic soils of the Firby and Howard Series are mapped adjacent to Hambleton Series soils. However, no attempt at explaining the distribution of stagnopodzols and brown soils is made.

The location of the different birch age classes has been influenced to coincide to more extent with Dimbleby's original age classes. Heather, thirty-five, forty-eight, sixty-three and eighty-three year old birch have been sampled thoroughly. Further restricted sampling was undertaken nearby on an area formerly under eighty year old pine, now under heather, regenerating birch and small replanted conifers.

(c) Experimental Design and Data Collection

At all four sites, three 15 x 15 m squares (replicates) were laid down at random within each age class. These soil pits were dug to a depth of roughly 80 cm at randomly located points within each replicate. A soil profile description was compiled for each soil pit, together with a few basic details of the immediate sites, using a recording sheet designed for handling and production of long-hand soil profile descriptions by computer (Howard et al, 1974). Soil profile descriptions produced by the PDP 11 computer at Bangor are attached. This system of computer handling is not as yet perfected and a few qualifying and explanatory remarks are attached as Appendix E. Eventually it is hoped that the system will be developed to allow searches and listings of the soil profile data to be made. This will help interpretation - a difficult task at present due to the sheer bulk of the material. However, interpretation and condensation of the data in a form allowing easier comparison of soils under the various age classes has been completed in tabular form.

The computer cannot handle the "Comments" section of the form. For the purposes of this report these are tabulated and included with the computer print-outs. Most of the soil features recorded are qualitative or semi-quantitative in nature. Soil chemistry has not been tested.

Soil samples were collected from the soil pits for the purposes of stone identification and characterisation of soil parent material. Lists of the stones identified are attached as Appendices A, B, C and D. Some of these same soil samples have been used by Aldyth Hatton for a mineralogical investigation of the uniformity or otherwise of the soil parent materials. A report on the mineralogy will be produced shortly. Samples of organic and/or organic-mineral surface horizons for thin section analysis by Aldyth Hatton were collected with great care in 10 x 5 x 5 cm metal boxes from representative soil pits at Tulchan only. These samples will also be the subject of a report by Aldyth Hatton in due course.

3. RESULTS

Each of the four sites will be treated separately. A table has been constructed for each site and contains condensed information on the site and soil profiles.

(a) Delnalyne Site No. 1

Age Classes 1 Heather moor
2 Twenty year old Birch

All eighteen soil pits are located on a fairly uniform moderate slope and are all within 40-50 metres of each other. Table I summarises the site and soil profile characteristics at each pit location.

(i) Vegetation

The vegetation of Age Class 1 is dominated by fairly tall *Calluna* with occasional wisps of *Deschampsia flexuosa* and fairly abundant mosses, especially *Pleurozium schreberi* and *Hylocomium splendens*. Age Class 2 is a thicket of *Betula pendula* with abundant *Deschampsia caespitosa* and *D. flexuosa*. *Hylocomium splendens* is fairly common and occasional *Calluna* plants occur. *Deschampsia caespitosa* suggests poor drainage conditions, though this does not imply that Age Class 1 is better drained through its absence there.

(ii) Soil Distribution

A strong contrast between the soils of the two Age Classes emerges. Under heather the soils are poorly drained with peaty gley podzols and peaty gleys (with standing water at about 60 cm depth in some pits). Most profiles have peaty tops, eluvial horizons and occasional humus deposition horizons (Bh) but no iron pans (Bf) or other iron deposition layer (Bs). L, F and peaty layers are present. Under the birch the soils are again poorly drained but are surface water gleys with no podzol features. There are no surface organic accumulations, eluvial or

TABLE I DELNALYNE (SITE 1) Condensed Soil Profile Characters

	SOIL PIT	ALTITUDE (m)	ASPECT (°)	SLOPE (°)	MAIN PLANT SPECIES*	LOCATION DRAINAGE	PROFILE DRAINAGE	SOIL GROUP (AVERY, 1973)	SOIL GROUP (TRADITIONAL)	NO. OF HORIZONS	L	F	O	E	Bh	Bf	Bs	COMMENTS
Heather moor	1/1/1	430	280	11	309 628 3463	Normal	Poor	Podzolic soil	Peaty gley/Peaty gley podzol	4	X	X	X	X				
	1/1/2	430	290	14	309 628 3346	Normal	Poor	Podzolic soil	Peaty gley podzol	6	X	X	X	X	X		X	
	1/1/3	430	280	13	309 628 3463	Normal	Poor	Podzolic soil	Peaty gley/Peaty gley podzol	5	X	X	X	X	X			
	1/2/1	430	280	7	309 3346, 3463	Normal	Poor	Podzolic soil	Peaty gley/Peaty gley podzol	4	X	X	X	X				
	1/2/2	430	280	10	309 3346, 3463	Normal	Poor	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X			
	1/2/3	430	280	9	309 3346, 3463	Normal	Poor	Podzolic soil	Peaty gley/Peaty gley podzol	4	X	X	X	X				
	1/3/1	430	290	8	309 628 3346, 3463	Normal	Poor	Stagnogley soil	Peaty gley	4	X	X	X					
	1/3/2	430	280	4	309 628	Normal	Poor	Stagnogley soil	Peaty gley	5	X		X					
	1/3/3	430	290	8	309 3346, 3463	Normal	Poor	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X			
20 year birch	2/1/1	430	280	11	309 627 239	Normal	Poor	Stagnogley soil	Gley	4								
	2/1/2	430	300	6	309 627 239	Normal	Poor	Stagnogley soil	Gley	3								
	2/1/3	430	300	8	309 627, 628, 239 3346	Normal	Poor	Stagnogley soil	Gley	3								
	2/2/1	430	320	8	627, 628, 239	Normal	Poor	Stagnogley soil	Gley	3								
	2/2/2	430	300	6	627, 628, 239 3346	Normal	Poor	Stagnogley soil	Gley	3								
	2/2/3	430	300	12	627, 628, 239	Normal	Poor	Stagnogley soil	Gley	3								
	2/3/1	430	300	6	627 239 3346	Normal	Poor	Stagnogley soil	Gley	3								
	2/3/2	430	260	6	309 239 3346	Normal	Poor	Stagnogley soil	Gley	3								
	2/3/3	430	270	8	627, 628, 239 3346	Normal	Poor	Stagnogley soil	Gley	3								

* 309 = Calluna vulgaris
627 = Deschampsia caespitosa
628 = Deschampsia flexuosa
239 = Betula pendula
3346 = Hylocomium splendens
3463 = Pleurozium schreberi

X = present, otherwise absent

illuvial horizon and the top-soils have the appearance, colour and crumb-structure associated with better drained soils in the lowlands.

(iii) Soil Profile Characters

If a soil map was to be produced covering the Delnalyne site and the adjacent hillside, a mapping unit boundary would be drawn between the two Age Classes, with the actual line coinciding with the edge of the birchwood. This suggests that the vegetation is strongly influencing the soils. However, brief observations close to the experimental site showed that the two soil types continue into an adjacent hill pasture with no obvious difference in the vegetation on either side of the soil mapping unit line. Assuming the hill pasture to have existed for a number of years, as seems likely, then the contrast in soils must be attributed to some other cause. Study of the full soil profile descriptions shows that under heather the soil textures (beneath the peaty top) are sandy silt loam or sandy loam. At a depth of between 35 and 60 cm from the surface the texture changes to sandy clay loam.

The birch soils tend to be heavier textured throughout - clay loam. The light surface textures of the heather soils will have aided eluviation and acidification. The incomplete podzol profiles noted are probably influenced by the heavier textures at depth and high water table. It is interesting to note that two heather soils, numbers 1/3/1 and 1/3/2 have the heavier-textured material much closer to the surface (12 cm) and one not podzolised. There seems to be a definite correlation between a surface sandy or silty drift in soils and podzolisation. The absence of this coarse surface drift from the birch soils is put forward as the reason for the lack of podzolisation.

(iv) Summary of Results

Although there are major differences between the soils of the heather and birch age classes at Delnalyne, the difference in the soils may be attributed to reasons other than the influence of birch. As such this site is unsuitable for this study although initially it would appear very useful due to the uniformity of other factors.

(b) Tulchan Site No. 2

Age Classes 1 Heather
2 18 year birch
3 26 year birch
4 38 year birch
5 90 year birch

Table II summarises site and soil characters for each pit.

(i) Vegetation

The vegetation of Age Class 1 is dominated by fairly tall *Calluna*. The mosses *Hylocomium splendens* and *Pleurozium schreberi* are fairly common and a few very young birches are found in one of the replicates. The eighteen year birch still retains an extensive *Calluna* cover together with the two mosses but *Vaccinium myrtillus* and *Deschampsia flexuosa* are common. The twenty-six year birch has only occasional *Calluna* and *Pleurozium*, but *Vaccinium myrtillus* and *Deschampsia flexuosa* dominate beneath the birch canopy. Under thirty-eight year old birch, *Deschampsia flexuosa* dominates, *Vaccinium myrtillus* is rare, and a little *Pteridium aquilinum* and other grasses and herbs are found. Under the oldest birch (ninety year) the vegetation has changed again and is dominated by *Pteridium aquilinum* with a fairly herb-rich sward beneath.

(ii) Soil Distribution

A clear trend from peaty gley podzols under heather and youngest birch to brown forest soils under the thirty-eight and ninety year old birch emerges.

Under the heather freely drained peaty gleyed podzols (with possible impeded drainage in the eluvial horizons) formed in very stony coarse-textured material are present. A generalised complete profile consists of L, F, Oh, Ea, Bh, Bs and Cx horizons.

TABLE II TULCHAN (SITE 2) Condensed Soil Profile Characters

	SOIL PIT	ALTITUDE (m)	ASPECT (°)	SLOPE (°)	MAIN PLANT SPECIES*	LOCATION DRAINAGE	PROFILE DRAINAGE	SOIL GROUP (AVERY, 1973)	SOIL GROUP (TRADITIONAL)	NO. OF HORIZONS	L	F	O	E	Bh	Bf	Bs	COMMENTS
	1/1/1	275	120	10	309 3463	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X		X	
	1/1/2	275	110	12	309 3346, 3463	Normal	Well	Podzolic soil	Peaty gley podzol/ Brown forest intergrade	5	X	X	X	X			X	
	1/1/3	275	120	12	309 3463	Normal	Well	Podzolic soil	Peaty gley podzol	4	X	X	X	X	X		X	
	1/2/1	275	120	8	309 3463	Normal	Well	Podzolic soil	Peaty gley podzol	4	X	X	X	X	X		X	
Heather	1/2/2	275	100	11	309 3346, 3463	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X		X	
	1/2/3	275	110	8	309 3346, 3463	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X		X	
	1/3/1	275	80	10	309 239 3346, 3463	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X		X	
	1/3/2	275	100	10	309 239 3346, 3463	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X		X	
	1/3/3	275	100	10	309 3346, 3463	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X		X	
	2/1/1	275	110	11	309 628, 239 3346, 3463	Normal	Well	Podzolic soil	Peaty gley podzol	7	X	X	X	X			X	
	2/1/2	275	120	10	309 2136, 628, 239 3346	Normal	Well	Podzolic soil	Peaty gley podzol	6	X	X	X	X	X		X	
	2/1/3	275	110	12	309 239 3346	Normal	Well	Podzolic soil	Peaty gley podzol	6		X	X	X	X		X	
	2/2/1	275	110	8	309 628, 239 3463	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X		X	
18 year birch	2/2/2	275	80	7	309 2136 239 3346	Normal	Well	Podzolic soil	Peaty gley podzol	6	X	X	X	X	X		X	
	2/2/3	275	110	9	309 2136, 628, 239 3463	Normal	Well	Podzolic soil	Peaty gley podzol	6	X	X	X	X	X	X	X	
	2/3/1	275	120	12	309 2136, 628, 239	Normal	Well	Podzolic soil	Peaty gley podzol	7	X	X	X	X	X	X	X	
	2/3/2	275	120	15	309 2136, 628, 239 3463	Normal	Well	Podzolic soil	Peaty gley podzol/ Brown forest intergrade	6		X		X			X	
	2/3/3	275	120	10	309 2136, 628, 239 3346, 3463	Normal	Well	Podzolic soil	Peaty gley podzol/ Brown forest intergrade	3		X	X	X			X	

(Continued)

	SOIL PIT	ALTITUDE (m)	ASPECT (°)	SLOPE (°)	MAIN PLANT SPECIES	LOCATION DRAINAGE	PROFILE DRAINAGE	SOIL GROUP (AVERY, 1973)	SOIL GROUP (TRADITIONAL)	NO. OF HORIZONS	L	F	O	E	Bh	Bf	Bs	COMMENTS
	3/1/1	260	150	5	2136, 628, 239	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X		X	
	3/1/2	260	150	7	2136, 628, 239	Normal	Well	Humic brown podzolic soil	Brown forest soil	4	X	X					X	
	3/1/3	260	170	11	2136, 628, 239	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X	X	X	
	3/2/1	260	160	5	2136, 628, 239	Normal	Well	Humic brown podzolic soil	Brown forest soil	4	X	X					X	
26 year birch	3/2/2	260	150	2	2136, 628, 239	Normal	Well	Humic brown podzolic soil	Brown forest soil	4	X	X	X				X	
	3/2/3	260	180	6	2136, 628, 239	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X		X	X		X	
	3/3/1	260	140	20	2136, 628, 239 3463	Normal	Well	Brown podzolic soil	Brown forest soil	3		X					X	
	3/3/2	260	140	14	309 2136, 628, 239	Normal	Well	Podzolic soil	Peaty gley podzol	5		X	X	X	X		X	
	3/3/3	260	145	8	2136, 628, 239	Normal	Well	Podzolic soil	Peaty gley podzol	10		X	X	X	X	X	X	
	4/1/1	245	160	12	2136, 628, 239	Shedding	Well	Podzolic soil	Peaty gley podzol/ Brown forest intergrade	5	X	X		X	X		X	Other grasses and herbs
	4/1/2	245	160	16	628, 239	Normal	Well	Brown podzolic soil	Brown forest soil	3	X	X					X	
	4/1/3	245	160	24	628, 239	Shedding	Well	Brown podzolic soil	Brown forest soil	3	X	X					X	
	4/2/1	245	155	19	628, 239	Shedding	Well	Brown podzolic soil	Brown forest soil	4	X	X					X	
38 year birch	4/2/2	245	160	16	628, 239	Shedding	Well	Brown podzolic soil	Brown forest soil	4	X	X					X	
	4/2/3	245	165	16	628, 239	Shedding	Well	Brown podzolic soil	Brown forest soil	4	X	X					X	
	4/3/1	245	155	21	628, 239	Normal	Well	Brown podzolic soil	Brown forest soil	3	X	X					X	
	4/3/2	245	160	18	2136, 628, 239	Shedding	Well	Brown podzolic soil	Brown forest soil	4		X			X		X	
	4/3/3	245	150	30	1619 628, 239	Normal	Well	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X		X	

(continued)

	SOIL PIT	ALTITUDE (m)	ASPECT (°)	SLOPE (°)	MAIN PLANT SPECIES	LOCATION DRAINAGE	PROFILE DRAINAGE	SOIL GROUP (AVERY, 1973)	SOIL GROUP (TRADITIONAL)	NO. OF HORIZONS	L	F	O	E	Bh	Bf	Bs	COMMENTS
	5/1/1	215	160	28	40, 121, 1619 628, 239	Normal	Well	Brown podzolic soil	Brown forest soil	3	X	X			X		X	
	5/1/2	215	160	28	40, 121, 1619 239	Normal	Well	Brown podzolic soil	Brown forest soil	4	X	X			X		X	
	5/1/3	215	160	30	40, 121, 1619 239	Normal	Well	Brown podzolic soil	Brown forest soil	4	X	X					X	
	5/2/1	215	160	30	40, 121, 1619 239	Normal	Well	Brown podzolic soil	Brown forest soil	3	X	X					X	
90 year birch	5/2/2	215	170	30	40, 121, 1619 239	Normal	Well	Podzolic soil	Peaty gley podzol/ Brown forest intergrade	7	X	X		X	X		X	
	5/2/3	215	160	18	40, 121, 1619 239	Normal	Well	Brown podzolic soil	Brown forest soil	3	X	X					X	
	5/3/1	215	160	22	40, 121, 1619 239	Normal	Well	Brown podzolic soil	Brown forest soil	3	X	X			X		X	
	5/3/2	215	160	28	40, 121, 1619 239	Normal	Well	Podzolic soil	Brown forest soil	5	X	X		X	X		X	
	5/3/3	215	170	22	40, 121, 1619 239	Normal	Well	Brown podzolic soil	Brown forest soil	4	X	X					X	

* 309 = Calluna vulgaris
121 = Anthoxanthum odoratum
2136 = Vaccinium myrtillus
239 = Betula pendula
3463 = Pleurozium schreberi
40 = Agrostis tenuis
1619 = Pteridium aquilinum
628 = Deschampsia flexuosa
3346 = Hylocomium splendens

X = present,
otherwise absent

Only traces of an iron pan were recorded (see comments on profile 010201) but possible cementation occurs at the base of some Ea horizons.

In general the soils under the eighteen year old birch are similar to those under heather. The generalised soil profile consists of L, F, Oh, Ea, Bh, Bs and Cx horizons. However, there is slightly more heterogeneity as some profiles lack L, Oh and Bh horizons and two profiles have iron pans. Two profiles (2/3/2 and 2/3/3) display characters which are brown forest soil in character.

Of the nine profiles in the twenty-six year old birch age class, four are brown forest soils and five are podzols. Both soil types occur in each of the three replicates, giving some idea of the heterogeneity of the soils here. Also, surprisingly each soil is "one or the other" without any apparent intergrades. There is a slight suggestion of an association between the brown forest soils with the denser parts of the birch canopy and the podzols with gaps in the canopy. This aspect would need further investigation to confirm whether or not such localised influences on the soils are in operation.

On the steeper slopes under thirty-eight year old birch, brown forest soils dominate (although two of the nine pits revealed podzols), with a typical profile consisting of L, F, A, Bs and Cx horizons.

Under the oldest birch and on steep slopes brown forest soils again dominate but once again two pits displayed podzol profiles. The typical profile consists of L, F, A, Bs and Cx horizons, but some of the brown forest soils showed evidence of thin Ea horizons beneath Ah or A horizons.

The distribution of soils seen here, with peaty gley podzols on the moderate slopes under heather moorland and brown forest soils under old birch woodland on steep slopes at lower altitude, fits neatly with the catenary sequence of soils described by various authors referred to in Section 2.

There is sufficient variation in altitude and slope to believe that the brown forest soils have been maintained in their present state by the site conditions of steep slope, lateral water/soil movement and lack of ability on the part of the vegetation to implement podzolisation. It is known that all age classes were formerly under heather, but it is not known whether those slopes now occupied by the oldest birch had brown forest soils or podzol soils when heather was the dominant species. Certainly a few of the soil pits under thirty-eight and ninety year old birch had podzol soils which might be interpreted as remnants of a former complete podzol cover. However, there is no reason to reject the theory that brown forest soils, together with small patches of podzols, occurred on these steep slopes. Muir and Fraser (1940) found that creep soils (brown forest soils) could exist under Calluna heath vegetation on slopes in an area of Scotland (Clashindarroch Forest) not too far from Tulchan.

(iii) Soil Profile Characters

To prove that birch is in any way acting to alter podzols to brown forest soils, evidence of alteration of podzol features to brown forest soil features must be found. Much of the evidence for the claim by Dimbleby (1952) of amelioration depended upon softening and disruption of the iron pan. However, in Tulchan podzols' iron pans are not normally present; only in one profile under heather was a trace of iron pan recorded (Profile 1/2/1) but this was extremely thin, black and soft. Iron pans are rarely found in the birch soils and are again generally thin, black and soft, but one or two profiles (especially 3/3/3) have a thin continuous, brittle hard pan unlike anything under the heather. For the purposes of this investigation, study of the iron pans or their possible dissolution is not of any help. In the place of iron pans are freely drained, soft, finely structured, brightly coloured Bs horizons. These are found below the leached horizons of the podzols and form the dominant B horizon in the brown forest soils. The universal distribution of these horizons throughout the soils of the site does not help the study. Their presence in brown forest soils does not suggest that the brown forest soil was formerly a podzol, now altered in its upper horizons, because brown forest soils and brown podzolics are accepted as normally having Bs horizons as a major component of their profiles.

If a podzol is in the process of alteration to a brown forest soil then it is the upper horizons which will show the changes. The peaty Oh horizon of the podzol should disappear, as should the Ea horizon, and in their place an A horizon with intimate mixture of organic and mineral material with well developed structure should be seen. This transformation is assumed to be the influence of more nutrient-rich birch litter, partly through its stimulating effect on the soil faunal population. Under the twenty-six year old birch Oh horizons are found in some of the soil profiles but are normally thinner than the Oh horizons under the younger birch and the heather. Litter and mottled rooty F horizons composed of birch leaves and Deschampsia flexuosa roots occur above the Oh horizons. This combination of Oh horizon formed presumably from heather and L F layers formed from birch and D. flexuosa roots is obviously transitional. The fact that the Oh horizons in this situation are comparatively thin may be interpreted as the result of greater soil mixing under the influence of birch, or it may be that the Oh horizons here were thinner originally while still under heather.

There is evidence that former Oh and Ea horizons of podzols have become mixed, especially under the eighteen and twenty-six year old birch. Under heather, the surface horizons consist of a black peaty Oh layer, generally quite fibrous but massive, followed by a light brownish grey humus-stained Ea layer. A transition zone between the two is 2-3 cm of the Oh horizon material with many conspicuous bleached sand grains. Signs of mixing of peaty and mineral material are possibly displayed by profiles with surface Ahe horizons (see 2/3/2, 3/2/2, 3/1/2, 3/2/3, 4/1/1) above the Ea. Also, with further mixing the Oh and Ea horizons become less distinct (but with bleached grains still present) and develop a much more open structure (profile 2/3/3) - rather different to the firm massive or compact single grain structures associated with the Oh and Ea horizons of the podzols. The change is structure is obviously connected with the large numbers of fibrous Deschampsia flexuosa roots (profiles 3/1/1, 3/3/2, 4/2/2, 4/3/1) which form an important component of the F layer under the twenty-six and thirty-eight year old birch.

Under the thirty-eight, twenty-six and to a certain extent the eighteen year old birch age classes, birch roots appear to be influencing the nature of the B horizons. Dark brown well structured B horizon material, contrasting with the normal bright Bs, is sometimes found in association with existing birch roots or what might formerly have been birch roots (see Profiles 2/2/1, 3/2/1, 2/1/3). This dark brown B appears to contain a higher proportion of organic matter than the Bs and may be due to decompostion of parts of or whole roots or due to soil microbiological associations or root exudates. In some cases, these dark brown zones are associated with the top of the indurated layer (Profile 3/2/3) which also has an accumulation of birch roots due to its impenetrability.

It has been proposed in the discussion of "creep" soils (Muir and Fraser, 1940) that soil creep acts to prevent podzolisation of soils on steep slopes. The ninety year and to some extent the thirty-eight year birch age classes are on steep slopes and the "creep" theory can be applied. However, soil mass movement may be fairly important even on less steep slopes. Some soil profiles at Tulchan (e.g. 1/3/3 and 3/3/3) have two Ea horizons and one explanation is that the original surface and soil profile has been buried by slumping. If this process occurs more widely on steeper slopes than those found at pits 1/3/3 and 3/3/3 then considerable mixing of the horizons may be envisaged.

(iv) Summary of Results

It is very difficult to separate the various influences on the nature of the soils at this site. However, a few conclusions may be drawn from the soil observations:-

- The podzol profiles under the heather, although having well developed Ea horizons do not have the massive, cemented iron pans often associated with podzols. This removes the toughest mechanical barrier to any amelioration of the soils.

- The effect of birch invasion, together with the corresponding ground flora changes, appears to be alteration of the nature of the surface L and F layers, and mixing of the Oh and Ea horizons of the podzol which eventually form a well structured homogeneous A horizon. This change seems to be affected partly by the influence of birch litter (and possibly canopy drip) on the soil surface, and partly by birch roots throughout the A, B and top of the C horizon which, especially in the B horizon where they are concentrated, have a localised influence on the soil structure, consistency, organic matter content and colour.

- Steep slopes under the ninety year old birch cannot be ruled out as a factor in the nature of the soils there. Brown forest soils are accepted as fairly normal under these circumstances and it is possible that such soils were present even under heather.

- The eighteen, twenty-six and thirty-eight year age classes provide the most convincing evidence for amelioration by birch. A study of some of the rather patchy birch cover here, attempting to correlate at a very local level (i.e. individual trees) brown forest soils and podzols with birch and heather respectively, might provide additional illuminating evidence as other influences such as slope, altitude etc. could be eliminated.

(c) Kerrow Site No. 5

Age Classes 1 Heather
2 Seventeen year birch
3 Twenty-six year birch
4 Sixty-nine year birch

Table III summarises the site and soil characters for each pit.

(i) Vegetation

Age Class 1 is a mixture of wet and dry *Calluna* heath. *Calluna* dominates with *Pleurozium schreberi* and *Hylocomium splendens* at the drier area, but *Calluna*, *Erica tetralix*, *Eriophorum* sp. and *Sphagnum* sp. occur also but not necessarily always with the wettest soils.

TABLE III KERROW (SITE 5) Condensed Soil Profile Characters

	SOIL PIT	ALTITUDE (m)	ASPECT (°)	SLOPE (°)	MAIN PLANT SPECIES*	LOCATION DRAINAGE	PROFILE DRAINAGE	SOIL GROUP (AVERY, 1973)	SOIL GROUP (TRADITIONAL)	NO. OF HORIZONS	L	F	O	E	Bh	Bf	Bs	COMMENTS
Heather	1/1/1	140	20	10	309 3346,3463	Receiving	Very poor	Humic gley soil	Peaty gley podzol?	3	X		X	X	X			
	1/1/2	140	330	4	309 Sphagnum sp. 3346,3463	Shedding	Well	Stagnopodzol	Peaty gley podzol/ Brown forest intergrade	7	X		X	X	X		X	
	1/1/3	140	360	12	309 3463	Normal	Moderate	Humus ironpan stagnopodzol	Peaty gley podzol	8	X	X	X	X	X	X	X	
	1/2/1	140	320	24	309,731 628	Normal	Well	Stagnopodzol	Peaty gley podzol/ Brown forest intergrade	5			X	X	X		X	
	1/2/2	140	340	8	309,731 Sphagnum sp. 3463	Receiving	Poor	Stagnopodzol	Peaty gley podzol	3	X	X	X	X	X		X	Eriophorum sp.
	1/2/3	140	360	4	309,731 Sphagnum sp. 3463	Shedding	Poor	Humus ironpan stagnopodzol	Peaty gley podzol	6	X		X	X	X	X		Eriophorum sp.
	1/3/1	140	20	6	309 3463	Normal	Well	Stagnopodzol	Peaty gley podzol	5	X	X	X	X			X	
	1/3/2	140	340	10	309 3346,3463	Normal	Imperfect	Brown podzolic soil	Humic brown forest soil	4	X	X	X				X	
	1/3/3	140	340	12	309 3346,3463	Normal	Poor	Stagnopodzol	Peaty gley podzol	4			X	X				Eriophorum sp.
17 year birch	2/1/1	140	350	8	309 244,1619,628,239 3346,3463	Normal	Moderate	Brown podzolic soil	Brown forest soil	3	X	X					X	
	2/1/2	140	345	21	309 244 628,239 3346,3463	Normal	Well	Brown podzolic soil	Brown forest soil	3	X	X					X	
	2/1/3	140	320	20	309 628,239 3346,3463	Normal	Well	Brown podzolic soil	Brown forest soil	3	X						X	
	2/2/1	140	340	14	309 1619,628,239 3346,3463	Normal	Imperfect	Brown podzolic soil	Imperfectly drained brown forest soil	4	X						X	Polytrichum sp.
	2/2/2	140	350	8	309 1619,628,239 3346,3463	Normal	Imperfect	Stagnopodzol	Peaty gley podzol/ Brown forest intergrade	6	X		X			X	X	
	2/2/3	140	310	14	309 239 3346,3463	Normal	Poor	Stagnohumic gley soil	Peaty gley	4	X		X					
	2/3/1	140	340	16	309 239 3346,3463	Normal	Poor	Stagnogley soil	Surface water gley	5	X	X	X					
	2/3/2	140	10	8	309,731,244 239 3346,3463	Normal	Poor	Stagnogley soil	Surface water gley	5	X		X		X			
	2/3/3	140	330	13	309 244 239 3463	Normal	Imperfect	Stagnogley soil	Imperfectly drained brown forest soil	5			X				X	

(Continued)

SOIL PIT	ALTITUDE (m)	ASPECT (°)	SLOPE (°)	MAIN PLANT SPECIES*	LOCATION DRAINAGE	PROFILE DRAINAGE	SOIL GROUP (AVERY, 1973)	SOIL GROUP (TRADITIONAL)	NO. OF HORIZONS	L	F	O	E	Bh	Bf	Bs	COMMENTS
26 year birch																	
(3/1/1	140	350	7	1619,628,239 3346,3463	Normal	Well	Brown podzolic soil	Brown forest soil	4	X						X	
(3/1/2	140	320	15	1619,628,239 Agrostis sp. 3346,3463	Normal	Imperfect	Brown podzolic soil	Brown forest soil	4	X						X	
(3/1/3	140	355	4	1619,628,239 Agrostis sp. 3463	Normal	Well	Brown podzolic soil	Brown forest soil	5	X						X	
(3/2/1	140	330	14	1619, 239 Agrostis sp. 3346,3463	Normal	Well	Brown podzolic soil	Brown forest soil	4	X						X	Festuca sp.
(3/2/2	140	340	13	1619 239 Agrostis sp. 3346,3463	Normal	Imperfect	Brown podzolic soil	Imperfectly drained brown forest soil	4							X	Festuca sp.
(3/2/3	140	340	11	244,1619 239 Agrostis sp. 3346,3463	Normal	Moderate	Brown podzolic soil	Brown forest soil	4	X						X	Festuca sp.
(3/3/1	140	360	3	1619 239 Agrostis sp. 3346	Normal	Imperfect	Stagnogley soil	Imperfectly drained brown forest soil	4								Festuca sp.
(3/3/2	140	340	5	244,1619 239 Agrostis sp. 3463	Normal	Well	Brown podzolic soil	Brown forest soil	3							X	Festuca sp.
(3/3/3	140	350	3		Normal	Imperfect	Brown podzolic soil	Brown forest soil	4							X	
69 year birch																	
(4/1/1	140	345	20	309 239 Agrostis sp. 3346,3463	Normal	Poor	Stagnogley soil	Brown forest soil	4					X		X	Festuca sp.
(4/1/2	140	340	10	309 1619,628,239 3346,3463	Normal	Well	Brown podzolic soil	Brown forest soil	5	X							
(4/1/3	140	340	16	1619,628,239 3346,3463	Normal	Well	Brown podzolic soil	Brown forest soil	4	X				X		X	
(4/2/1	140	340	10	244,1619 239 Agrostis sp. 3346,3463	Normal	Well	Brown podzolic soil	Brown forest soil	3							X	Festuca sp.
(4/2/2	140	340	10	244,1619 239 Agrostis sp. 3346,3463	Normal	Well	Brown podzolic soil	Brown forest soil	4	X						X	Festuca sp.
(4/2/3	140	345	12	244,1619 239 Agrostis sp. 3463	Normal	Well	Brown podzolic soil	Brown forest soil	3							X	Festuca sp.
(4/3/1	140	340	19	244,1619 239 Agrostis sp. 3463	Normal	Poor	Stagnogley soil	Poorly drained brown forest soil?	4	X							Festuca sp.
(4/3/2	140	360	17	244,1619 239 Agrostis sp. 3346	Normal	Well	Brown podzolic soil	Brown forest soil	3	X						X	Festuca sp.
(4/3/3	140	360	20	244,1619 239 Agrostis sp. 3463	Normal	Well	Brown podzolic soil	Brown forest soil	4	X						X	Festuca sp.

* 309 = Calluna vulgaris 3463 = Pleurozium schreberi
731 = Erica tetralix 2136 = Vaccinium myrtillus**
244 = Blechnum spicant 240 = Betula pubescens**
1619 = Pteridium aquilinum 1728 = Rubus fruticosus**
628 = Deschampsia flexuosa 1413 = Oxalis acetosella**
239 = Betula pendula 1188 = Lonicera periclymenum**
3346 = Hylocomium splendens 477 = Chamaenerion angustifolium** ** Table IV

X = present, otherwise absent

Under seventeen year old birch, Calluna, Pleurozium and Hylocomium are universal, but Deschampsia flexuosa, Pteridium, and Blechnum are common. Pteridium becomes dominant under twenty-six year old birch. Agrostis and Festuca are widespread, Deschampsia flexuosa and Blechnum are common but less abundant than under seventeen year old birch, and the two mosses, Pleurozium and Hylocomium, remain very common.

Finally, the sixty-nine year old birch age class is dominated by Pteridium with an understorey of Agrostis, Festuca, Pleurozium and Hylocomium. Blechnum is common, and Calluna and Deschampsia flexuosa are represented by only a few plants.

Pteridium, Blechnum, Deschampsia flexuosa, Agrostis and Festuca are obviously associated with the birch, with Deschampsia found more under the youngest birch and Agrostis/Festuca more under the older birch. During pit excavation it was noticed that in a few of the shallower pits over solid rock lateral water movement down-slope was considerable at certain points along the slope. This movement of water may be acting as a means of enriching the nutrient status of the soils of those age classes lowest on the slope.

(ii) Soil Distribution

The main trend is of peaty gley podzols under heather to brown forest soils under the oldest Birch. This trend is not as well pronounced as for Tulchan, due mainly to the irregular relief, especially at the Heather age class. Here, as can be seen from Table III, the slopes are varied, and the location and profile drainage show a range of classes from receiving to shedding and very poor to well-drained respectively. This irregular relief may be explained by a thin blanket of drift which only partly obscures the underlying rugged rock surface, resulting in a land-form which partly reflects that rock surface. A few small rock outcrops were seen at the site, and some of the soil pits hit solid rock within profile depth.

Under the heather small basin sites and drainage lines have poorly drained peaty gley podzols (some of which are more like peaty gleys than podzols). Well drained podzols, brown forest soils or intergrades between these two are normal however, but overall the soil pattern is quite heterogeneous. All soils have peaty tops, but podzol E, Bh, Bf and Bs horizons are not universal under the heather and iron pans (Bf) are not normal. The soil pattern is not unusual, considering the non-uniform terrain for a site of this type, and it is interesting that a brown forest soil, admittedly with a fairly thick peaty top, can exist under heather (profile 1/3/2).

The seventeen year old birch age class has mainly brown forest soils, but peaty and surface water gleys also occur along drainage lines. These brown forest soils are well developed and present none of the features of the podzols under the heather except the one imperfectly drained example which has a peaty top.

Brown forest soils alone are found in the twenty-six year birch, although two examples were imperfectly drained possibly due to slight basin features on the surface, or the proximity of rock to the surface. A typical profile would consist of L, Ah, A, Bs and Cx horizons. Brown forest soils are also the only soils found under sixty-nine year old birch. One profile was described as poorly drained (4/3/1) for the reason that rock was encountered at a depth of 69 cm and water was seen to run laterally down the hillside through the soil at the pit bottom. Otherwise the soil structure and texture suggested that the soil ought to be freely drained. The typical brown forest soil profile consisted of L, A, Bs and Cx horizons.

The distribution of soils at this site, despite complications due to the presence of a few poorly drained gleys, fits neatly with the previously discussed ideas on the catenary sequence of soils on slopes and moorland edge. The reason for the observed distribution of podzols under heather and brown forest soils under birch can most easily be explained as the influence of birch. At first glance the influence of slope under the birch does not appear any different to that under the heather, the average slope for each age class being as follows:-

Age Class	1	Slope (°)	10.0
	2		13.5
	3		8.3
	4		14.8

As has been mentioned the ground surface of the heather age class is somewhat erratic and any process involving mass movement of soil, such as soil creep, might not be expected.

The birch age classes, although displaying a variety of slope angles and average angles which are not always steeper than those of the heather, may be considered as different in that the slopes are more continuous and amenable to soil creep. This idea is not entirely true for the seventeen year old birch, however. Perhaps this theory, together with the general increase in altitude (not represented accurately in Table III) might explain the soil distribution.

(iii) Soil Profile Characters

The soils observed at this site did not show any features which might have been attributed to an active regeneration of a brown forest soil from a podzol. Iron pans are not common in the peaty podzols, and no trace of them either intact or in process of dissolution was found in the brown forest soils as an indicator of the former nature of the latter soils. The soils under heather have peaty tops but there is no trace of these under even the youngest birch. It seems unlikely that, in the event of a transformation from podzol to brown forest soil, such well developed peaty horizons could be incorporated so quickly.

(iv) Summary of Results

- Peaty gleyed podzols and brown forest soils are found to be associated almost entirely with heather and birch age classes respectively.

- It is possible that continuity of slope and variation in altitude may have influenced this distribution.

- There are visible signs in the brown forest soil profiles under the birch of active transformation of podzol features to brown forest soil features.

- It is probable that a number of influences are acting on the soils and presenting the observed distribution. The action of any one factor cannot be given credit for any soil transformation which may have been claimed to have taken place.

- An adjacent site covering the entire altitudinal range of the age classes studied (but with heather or birch only) would be useful for comparative purposes. This would allow further details of climatic and relief factors and vegetation factors to be studied.

(d) Silpho Site No. 8

Age Classes	0	Heather
	1	Former eighty year pine
	2	35 year birch
	3	48 year birch
	4	63 year birch
	5	83 year birch

Table IV summarises the site and soil characters for each pit.

(i) Vegetation

Age Class 0 is an area of tall, rather leggy heather with a patchy cover of *Pleurozium schreberi* growing among the stems. *Pteridium aquilinum* occurs as small local clumps.

Age Class 1 is a former pine plantation, felled at about eighty years of age and now replanted mainly with larch. However, large numbers of birch saplings have sprung up and at some points in the area these dominate. At some points here, rather wet conditions appear to have resulted in *Carex* spp. occurring, but in

TABLE IV SILPHO (SITE 8) Condensed Soil Profile Characters

SOIL PIT		ALTITUDE (m)	ASPECT (°)	SLOPE (°)	MAIN PLANT SPECIES*	LOCATION DRAINAGE	PROFILE DRAINAGE	SOIL GROUP (AVERY, 1973)	SOIL GROUP (TRADITIONAL)	NO. OF HORIZONS	L	F	O	E	Bh	Bf	Bs	COMMENTS
Heather	0/1/1	175	-	0	309 3463	Normal	Imperfect	Humus ironpan stagnopodzol	Peaty gley podzol	6	X	X	X	X	X	X	X	
	0/1/2	175	-	0	309, 1619	Normal	Imperfect	Humus ironpan stagnopodzol	Peaty gley podzol	8	X	X	X	X	X	X	X	
	0/1/3	175	-	0	309,1619 3463	Normal	Imperfect	Humus ironpan stagnopodzol	Peaty gley podzol	6	X	X	X	X	X	X	X	
	0/2/1	175	-	0	309 2136 3463	Normal	Imperfect	Humus ironpan stagnopodzol	Peaty gley podzol	6	X	X	X	X	X	X	X	
	0/2/2	175	-	0	309 3463	Normal	Imperfect	Humus ironpan stagnopodzol	Peaty gley podzol	8	X	X	X	X	X	X	X	
	0/2/3	175	-	0	309 3463	Normal	Imperfect	Humus ironpan stagnopodzol	Peaty gley podzol	6	X	X	X	X	X	X	X	
	0/3/1	175	-	0	309, 1619	Normal	Imperfect	Humus ironpan stagnopodzol	Peaty gley podzol	5	X	X	X	X	X	X	X	
	0/3/2	175	-	0	309 3463	Normal	Imperfect	Humus ironpan stagnopodzol	Peaty gley podzol	7	X	X	X	X	X	X	X	
	0/3/3	175	-	0	309 3463	Normal	Imperfect	Humus ironpan stagnopodzol	Peaty gley podzol	6	X	X	X	X	X	X	X	
Former 80 year pine	1/2/1	185	-	0	309 3463	Normal	Moderate	Podzolic soil	Peaty gley podzol	6	X	X	X	X	X	X	X	
	1/3/1	185	-	0	309 2136, 628, 240 3463	Normal	Moderate	Podzolic soil	Peaty gley podzol	6	X	X	X	X	X	X	X	Young Larch
	1/4/1	185	-	0	309 2136 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X	X		Carex spp.
	1/6/1	185	-	0	309 2136, 628, 240 3463	Normal	Moderate	Podzolic soil	Peaty gley podzol	7	X	X	X	X		X	X	

(Continued)

	SOIL PIT	ALTITUDE (m)	ASPECT (°)	SLOPE (°)	MAIN PLANT SPECIES*	LOCATION DRAINAGE	PROFILE DRAINAGE	SOIL GROUP (AVERY, 1973)	SOIL GROUP (TRADITIONAL)	NO. OF HORIZONS	L	F	O	E	Bh	Bf	Bs	COMMENTS
35 year birch	3/1/1	185	310	3	2136, 628, 240	Normal	Moderate	Ironpan stagnopodzol	Peaty gley podzol	4	X	X	X	X		X	X	
	3/1/2	185	320	2	628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	5		X		X	X		X	
	3/1/3	185	330	3	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	7		X	X	X	X	X	X	
	3/2/1	185	320	2	628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	5		X	X	X	X	X	X	
	3/2/2	185	340	2	628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	6		X	X	X	X		X	
	3/2/3	185	290	3	628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	5		X	X	X	X		X	
	3/3/1	185	310	2	628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	6		X	X	X	X	X	X	
	3/3/2	185	300	4	628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	6		X	X	X	X		X	
	3/3/3	185	300	3	628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	5		X	X	X	X	X	X	
48 year birch	4/1/1	175	-	0	1619, 2136, 628, 240, 1728	Normal	Moderate	Podzolic soil	Peaty gley podzol	7	X	X	X	X	X	X	X	
	4/1/2	175	-	0	2136 240, 1728	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	7	X	X	X	X	X	X	X	
	4/1/3	175	-	0	2136, 628, 240, 1728	Normal	Moderate	Podzolic soil	Peaty gley podzol	3		X		X		X	X	
	4/2/1	175	-	0	309 2136, 628, 240, 1728	Normal	Moderate	Podzolic soil	Peaty gley podzol	5		X	X	X	X	X	X	
	4/2/2	175	-	0	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	5		X	X	X	X	X	X	
	4/2/3	175	-	0	2136, 628, 240 1413	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	5	X	X	X	X	X		X	
	4/3/1	175	-	0	1619, 2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	6		X	X	X	X	X	X	
	4/3/2	175	-	0	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	5	X	X	X	X	X	X	X	
	4/3/3	175	-	0	1619, 2136 240	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	5	X	X	X	X	X		X	

(Continued)

	SOIL PIT	ALTITUDE (m)	ASPECT (°)	SLOPE (°)	MAIN PLANT SPECIES*	LOCATION DRAINAGE	PROFILE DRAINAGE	SOIL GROUP (AVERY, 1973)	SOIL GROUP (TRADITIONAL)	NO. OF HORIZONS	L	F	O	E	Rh	Bf	Bs	COMMENTS
63 year birch	5/1/1	175	-	0	628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	5		X	X			X	X	
	5/1/2	175	-	0	2136, 628, 240 1413	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	5		X	X			X	X	
	5/1/3	175	-	0	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	5		X	X	X	X	X	X	
	5/2/1	175	-	0	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	6		X	X	X	X	X	X	
	5/2/2	175	-	0	309 2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	8		X	X	X	X	X	X	
	5/2/3	175	-	0	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	5		X		X	X	X	X	
	5/3/1	175	-	0	309 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol	6		X		X	X	X	X	
	5/3/2	175	-	0	628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	3		X					X	
	5/3/3	175	-	0	309 2136, 628, 240, 1728	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	7		X		X	X	X	X	
83 year birch	6/1/1	185	290	1	2136, 628, 240 1188	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	6		X	X	X	X		X	
	6/1/2	185	290	1	2136, 628, 240 1188	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	5		X				X	X	
	6/1/3	185	290	2	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	7		X	X	X	X	X	X	
	6/2/1	185	240	2	628, 240 1413 477	Normal	Moderate	Podzolic soil	Brown podzolic	4		X		X			X	
	6/2/2	185	270	2	2136, 628, 240	Normal	Moderate	Podzolic soil	Brown podzolic	3		X		X	X		X	
	6/2/3	185	270	2	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	5		X	X	X	X		X	
	6/3/1	185	280	1	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	6		X	X	X	X	X	X	
	6/3/2	185	-	0	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	6		X	X	X	X	X	X	
	6/3/3	185	280	2	2136, 628, 240	Normal	Moderate	Podzolic soil	Peaty gley podzol/ Brown podzolic intergrade	6		X	X	X	X	X	X	

*See Table III for species names

X = present, otherwise absent

general Calluna, Vaccinium myrtillus and Deschampsia flexuosa are common.

The thirty-five year old birch has an almost uniform cover of dense Deschampsia flexuosa with occasional weak plants of Vaccinium myrtillus, with no sign of Calluna.

Under the forty-eight year birch, Deschampsia flexuosa and Vaccinium myrtillus are universal and common, but patches of Pteridium aquilinum and Rubus fruticosus are also present.

The sixty-three year old birch is slightly more open in character. The ground flora is dominated by Deschampsia flexuosa and Vaccinium myrtillus but plants of Calluna are found.

Finally the eighty-three year old birch is very open, but is still dominated by Deschampsia flexuosa and Vaccinium myrtillus. Odd plants of Chamaenerion angustifolium occur, accentuating this more open character but possibly indicating some kind of recent soil disturbance.

(ii) Soil Distribution

The soils at Silpho show less variability than those at the three other sites. The heather soils are certainly well developed podzols but the birch soils, although some display brown podzolic profiles, are generally rather poorly developed podzols or peaty gley podzol/brown podzolic intergrades.

In Age Class 0, peaty gley podzols with L and F layers and fairly thick peaty Oh layers occur. The firm, single-grain E horizons are strongly stained by humus presumably in transit through these horizons. A confusion of strongly cemented iron pan, Bh horizon, Bs horizon, often at the top of an indurated C horizon, makes description of the lower half of these profiles difficult. Although the upper half of these profiles are comparatively freely drained, except for the local waterlogging effect of the surface peat, the iron pan and indurated layer must impede drain-

The best developed podzols at Silpho are found on Age Class 1. The Ea horizons are only slightly humus-stained and the Bh, Bf and Bs horizons are all well differentiated giving the colour contrast which is so characteristic of the classic podzol profile. This may well be an effect associated with the eighty years under pine which may have enhanced these features of the pre-existing podzol.

The thirty-five year old birch age class has peaty gleyed podzol soils but with a few differences from those under heather. Iron pans are not as common, litter layers are not present, and the Oh and Bh horizons are not always present.

The forty-eight year birch soils are mainly peaty gley podzols, but some profiles have no iron pans and these A horizons are more reminiscent of brown podzolics.

Litter layers are not found under the sixty-three year old birch, at least not during the summer months. Any leaf litter seems to be incorporated into a matted, rooty F layer under the carpet of Deschampsia flexuosa which is universal under the older birch. Some of the soils in this age class show evidence of having been better developed podzols at one time. Iron pans are found in most profiles, but the Ea, Oh and Bh horizons are often replaced by a less differentiated A horizon, possibly indicating conversion towards a brown podzolic.

Under the eighty-three year old birch, some profiles show the characters of brown podzolic soils, although they still possess traces of E horizons, but in general the soils are intergrades between podzols and brown podzolics. Iron pans are found in only half of the profiles, but E and Bh horizons are normal although not as well differentiated as in the podzols under heather and younger birch.

(iii) Soil Profile Characters

A number of profile characters change from the soils under heather through to the oldest birch soils. Litter and F layers composed of Calluna debris are found in Age classes 0 and 1, but under all other age classes, only F layers are normally found, and these are of a different nature, composed of birch leaf material matted together by abundant fine Deschampsia flexuosa roots. This suggests a much more rapid disintegration of birch litter than heather litter. Peaty O horizons are universal under heather, rarely absent under thirty-five and forty-eight year birch and common under the older two birch age classes. However, the thickness of this peaty surface decreases with increasing birch age, it becomes less differentiated in terms of colour, it has a larger proportion of mineral material mixed in, and fibrous roots become common. All of these factors indicate that some degree of incorporation or loss of the peaty surface is in progress.

Eluvial horizons are well developed under the heather, but with increasing age of birch these also become less well differentiated and although shown to be very commonly found even under the oldest birch by Table IV they become progressively more like A horizons (profiles 6/1/2 and 5/3/2). The structure improves, organic matter from Oh and Bh horizons shows a greater degree of incorporation, the colour takes on a browner shade, and in general the whole top-soil becomes more uniform.

The better structure is often localised in the A or Ea horizons and is found to be associated with roots in some cases (profile 5/3/2).

It is the iron pans which give the best evidence for the improvement from a podzol. The iron pans of the heather soils tend to be strongly cemented, thick, brittle and impermeable. The pans are less frequent under the birch. Often they are absent but where present they are very thin and with only localised cementation, or soft and crumbly (6/3/1). Occasionally soft incomplete pans are found which should provide no barrier to root penetration but have a mat of roots above. This suggests that at some time the pan was more solid and has fairly recently undergone some kind of chemical or mechanical disintegration.

(iv) Summary of Results

- Despite the scattered positions of the different age classes, most soil-forming factors seem uniform, except for the vegetation. There is no reason to suspect that the soils under the birch were anything other than well developed podzols. If this is the case then the variation in soils may be attributed to the influence of the invasion by birch.

- Although many of the soil profiles, even under the oldest birch, still retain many podzol features, the original podzol soils show considerable profile differentiation and B horizon cementation and it is not surprising that the changes taking place are slow.

CONCLUSIONS

(a) Delnalyne is unsuitable for this study due to soil variations resulting from parent material differences.

(b) Tulchan and Kerrow are similar in that any influence of birch on the soils may also be attributed to altitude and slope etc. At Kerrow the influence of birch is not convincing. At Tulchan, however, a number of soil profile features were noted which suggested a certain degree of improvement towards a brown forest soil type from a podzol.

(c) At Silpho all important soil-forming factors except vegetation were constant, and the fairly small improvement in the soils may be attributed to the effects of birch invasion and its attendant ground flora changes.

(d) It is believed that birch has altered the nature of soils to some degree at all of the sites studied. The amount of change produced would appear to be quite dramatic in some cases, but it cannot be proved that it is birch which is causing this change. Other, less dramatic, changes may be attributed to birch. So long as the podzolisation process has not progressed too far, and so long as plenty of time is allowed, it is thought that birch may have a valuable role to play in amelioration of podzol soils.

Appendix A

Main stone types identified from Delnalyne soil samples

Decreasing abundance from left to right. Shape given is that most commonly occurring.

1/1/1/1/1	Angular white schist, white metamorphosed sandstone, quartz, micaceous sandstone
1/1/1/1/2	Subangular white schist, pink metamorphosed sandstone, micaceous sandstone, quartzite
1/1/1/2/1	Subangular (plus a few rounded) white schist, quartzite, quartz, micaceous sandstone
1/1/1/2/2	Subangular white and pink schist, white and pink metamorphosed sandstone, quartzite, micaceous sandstone
1/1/1/3/1	Angular and subangular white schist, soft fine white sandstone, granite, quartzite, quartz, micaceous sandstone
1/1/1/3/2	Rounded pink hard schist, micaceous sandstone, quartzite
1/1/2/1/1	Angular white schist, white metamorphosed sandstone, quartzite, quartz, micaceous sandstone
1/1/2/1/2	Angular quartzite, pink schist, pink metamorphosed sandstone, micaceous sandstone
1/1/2/2/1	Angular quartzite, white schist, soft fine white sandstone, micaceous sandstone
1/1/2/2/2	Subangular and angular pink schist, micaceous sandstone, quartzite
1/1/2/3/1	Few angular quartzite only
1/1/2/3/2	Rounded pink schist, pink metamorphosed sandstone, micaceous sandstone, quartzite
1/1/3/1/1	Few small angular white schist, micaceous sandstone, quartz
1/1/3/1/1a	Angular white schist, quartzite, metamorphosed white sandstone, quartz, micaceous sandstone
1/1/3/1/2	Subangular metamorphosed white sandstone, white schist, micaceous sandstone, quartz
1/1/3/2/1	Angular quartz, micaceous sandstone, white schist
1/1/3/2/2	Subangular white schist, quartz, micaceous sandstone
1/1/3/2/3	Subangular white schist, white metamorphosed sandstone, pink metamorphosed sandstone, micaceous sandstone, quartz
1/1/3/3/1	Angular quartzite, white schist, micaceous sandstone, quartz
1/1/3/3/2	Angular pink metamorphosed sandstone, pink schist, micaceous sandstone, quartzite
1/2/1/1/1	Angular white schist, metamorphosed white sandstone, quartzite
1/2/1/1/2	Subangular pink and white schist, quartzite, Fe/Mn concretions, micaceous sandstone
1/2/1/2/1	Angular metamorphosed white sandstone, metamorphosed pink sandstone, quartzite, quartz
1/2/1/2/2	Angular pink schist, pink metamorphosed sandstone, quartzite, quartz, micaceous sandstone
1/2/1/2/3	Angular pink metamorphosed sandstone, pink schist, micaceous sandstone, very dark red sandstone
1/2/1/3/1	Angular quartzite, quartz
1/2/1/3/2	Subangular metamorphosed pink sandstone, pink schist, micaceous sandstone, quartzite, highly micaceous sandstone
1/2/2/1/1	Few small angular quartz
1/2/2/1/2	Subangular quartzite, white and pink schist, white and pink metamorphosed sandstone, micaceous sandstone
1/2/2/2/1	Few angular quartz, white schist
1/2/2/2/2	Subangular metamorphosed white sandstone, white schist, micaceous sandstone, quartzite, pink sandstone
1/2/2/3/1	Angular quartzite, soft white fine sandstone, micaceous sandstone, quartz
1/2/2/3/2	Angular pink very hard sandstone, micaceous sandstone, quartz
1/2/3/1/1	Angular white metamorphosed sandstone, quartz, white schist, micaceous sandstone
1/2/3/1/2	Subangular quartzite, white schist, metamorphosed white sandstone, micaceous sandstone
1/2/3/2/1	Subangular metamorphosed pink sandstone, quartzite, metamorphosed white sandstone, quartz, fine yellow sandstone, micaceous sandstone

1/2/3/2/2	Angular metamorphosed pink sandstone, pink schist, micaceous sandstone, quartz, very dark red sandstone
1/2/3/3/1	Subangular and rounded granite, metamorphosed white sandstone, quartz
1/2/3/3/2	Angular metamorphosed white sandstone, quartzite, white schist, pink sandstone, micaceous sandstone
1	Angular white schist, pink schist, white and pink metamorphosed sandstone, quartzite, micaceous sandstone
2	Subangular white schist, quartz, micaceous sandstone, quartzite
3	Angular metamorphosed pink sandstone, metamorphosed white sandstone, white schist, micaceous sandstone, quartz
4	Angular pink sandstone, white schist, quartzite, quartz, micaceous sandstone, mica schist
5	Angular quartzite, white schist, pink sandstone, micaceous sandstone, quartz
6	Angular white schist, quartz, quartzite, metamorphosed sandstone
7	Angular white metamorphosed sandstone, white schist, quartz, micaceous sandstone
8	Angular quartz, quartzite, micaceous sandstone, white schist, quartz
9	Subangular pink schist, metamorphosed white sandstone, quartzite, metamorphosed pink sandstone, micaceous sandstone, quartz

Appendix B

Main stone types identified from Tulchan soil samples

Decreasing abundance from left to right. Shape given is that most commonly occurring.

2/1/1/1/1	Angular white quartzite, schist, quartz
2/1/1/1/2	Subangular white quartzite, micaceous sandstone, quartz
2/1/1/1/3	Angular white quartzite, quartz
2/1/1/1/4	Angular white quartzite, schist, granite, micaceous sandstone, quartz
2/1/1/1/5	Angular white quartzite, granite, micaceous sandstone, rounded white schist
2/1/1/2/1	Subangular white quartzite, micaceous sandstone, schist, quartz
2/1/1/2/2	Subangular white quartzite, micaceous sandstone, granite, quartz
2/1/1/2/3	Angular white quartzite, schist, granite fragments, micaceous sandstone.
2/1/1/2/4	Subangular white quartzite, granite, micaceous sandstone, schist
2/1/1/2/5	No sample of stones
2/1/1/3/1	Angular white quartzite.
2/1/1/3/2	Angular white quartzite, micaceous sandstone, quartz
2/1/1/3/3	Subangular white quartzite, buff sandstone, micaceous sandstone, quartz
2/1/1/3/4	Angular white quartzite, schist, micaceous sandstone, granite fragments, quartz
2/1/2/1/1	Angular white quartzite.
2/1/2/1/2	Angular white quartzite, micaceous sandstone, quartz
2/1/2/1/3	Angular quartzite, white schist, micaceous sandstone
2/1/2/1/4	Angular and a few rounded white quartzite, micaceous sandstone, schist, quartz
2/1/2/2/1	Angular white quartzite, quartz
2/1/2/2/2	Angular white quartzite, quartz
2/1/2/2/3	Angular white quartzite, quartz, buff sandstone, micaceous sandstone
2/1/2/2/4	Angular white quartzite, schist, micaceous sandstone, quartz
2/1/2/2/5	Angular white quartzite, quartz, micaceous sandstone.
2/1/2/3/1	Angular white quartzite, quartz
2/1/2/3/2	Angular white quartzite, micaceous sandstone, quartz
2/1/2/3/3	Angular white quartzite, micaceous sandstone, quartz
2/1/2/3/4	Angular white quartzite, micaceous sandstone, quartz, buff sandstone
2/1/2/3/5	Angular white quartzite, schist, micaceous sandstone, quartz
2/1/3/1/1	Angular white quartzite.
2/1/3/1/2	Angular white quartzite, buff sandstone, micaceous sandstone, quartz
2/1/3/1/3	Subangular white quartzite, schist, micaceous sandstone, quartz
2/1/3/1/4	Angular quartzite, white schist, quartz
2/1/3/1/5	Angular white quartzite, micaceous sandstone
2/1/3/2/1	Angular white quartzite, quartz
2/1/3/2/2	Subangular white quartzite, micaceous sandstone, quartz
2/1/3/2/3	Angular white quartzite, schist, buff sandstone, micaceous sandstone, quartz
2/1/3/2/4	Angular white quartzite, buff sandstone, micaceous sandstone, quartz
2/1/3/2/5	Angular white quartzite, schist, micaceous sandstone, quartz
2/1/3/3/1	Angular white quartzite, quartz
2/1/3/3/2	Angular white quartzite, micaceous sandstone, quartz
2/1/3/3/3	Angular white quartzite, micaceous sandstone, quartz, buff sandstone
2/1/3/3/4	Angular white quartzite, schist, micaceous sandstone.
2/1/3/3/5	Angular white quartzite, micaceous sandstone, quartz
2/2/1/1/1	Subangular white quartzite.
2/2/1/1/2	Angular white quartzite, schist, micaceous sandstone, quartz
2/2/1/1/3	Angular white quartzite, schist, quartz
2/2/1/1/4	Angular white quartzite, granite, schist, quartz
2/2/1/1/5	Angular white quartzite, schist, micaceous sandstone, quartz
2/2/1/1/6	Angular white quartzite, schist, micaceous sandstone,
2/2/1/1/7	No sample of stones
2/2/1/2/1	Angular white quartzite, quartz
2/2/1/2/2	Angular white quartzite, micaceous sandstone, quartz

2/2/1/2/3	Angular white quartzite, schist, buff sandstone, micaceous sandstone, quartz
2/2/1/2/4	Angular white quartzite, quartz, micaceous sandstone, granite fragments
2/2/1/2/5	Angular white quartzite, granite, micaceous sandstone, quartz
2/2/1/2/6	Angular white quartzite, granite, micaceous sandstone, quartz
2/2/1/3/1	Angular white quartzite, quartz
2/2/1/3/2	Angular white quartzite, micaceous sandstone, quartz
2/2/1/3/3	Subangular white quartzite, schist, buff sandstone, micaceous sandstone,quart
2/2/1/3/4	Angular quartzite, white schist, micaceous sandstone.
2/2/1/3/5	Subangular white quartzite, schist
2/2/1/3/6	Angular white quartzite, schist, granite, micaceous sandstone, quartz
2/2/2/1/1	Angular white quartzite, micaceous sandstone
2/2/2/1/2	Angular white quartzite, schist, micaceous sandstone, quartz
2/2/2/1/3	Angular white quartzite, micaceous sandstone, quartz
2/2/2/1/4	Angular white quartzite, mica sandstone, quartz
2/2/2/1/5	Angular white quartzite, schist, granite, micaceous sandstone, quartz
2/2/2/2/1	Angular quartzite, quartz
2/2/2/2/2	Subangular white quartzite, schist, micaceous sandstone, quartz
2/2/2/2/3	Angular white quartzite, buff sandstone, quartz
2/2/2/2/4	Angular white quartzite, quartz
2/2/2/2/5	Angular and rounded white quartzite, angular schist, micaceous sandstone, quartz
2/2/2/2/6	Angular white quartzite, schist, granite, micaceous sandstone, pink sandstone
2/2/2/3/1	Angular white quartzite, quartz
2/2/2/3/2	Angular white quartzite, micaceous sandstone, quartz
2/2/2/3/3	Angular white quartzite, schist, granite, micaceous sandstone
2/2/2/3/4	Angular white quartzite, micaceous sandstone, buff sandstone, quartz
2/2/2/3/5	Angular white quartzite, schist, micaceous sandstone, quartz
2/2/3/1/1	Angular white quartzite, quartz
2/2/3/1/2	Angular white quartzite, schist, micaceous sandstone.
2/2/3/1/3	Angular white quartzite, micaceous sandstone, buff sandstone,quartz
2/2/3/1/4	Angular white quartzite, micaceous sandstone, granite, quartz
2/2/3/1/5	Angular white quartzite, schist, micaceous sandstone
2/2/3/1/6	No sample of stones
2/2/3/2/1	Angular white quartzite, schist, micaceous sandstone, quartz
2/2/3/2/2	Angular white quartzite, micaceous sandstone, quartz
2/2/3/2/3	Angular white quartzite, quartz, micaceous sandstone
2/2/3/2/4	Angular white quartzite, schist, granite, micaceous sandstone
2/2/3/2/5	Angular white quartzite, schist, micaceous sandstone, quartz
2/2/3/3/1	Angular white quartzite, micaceous sandstone, quartz
2/2/3/3/2	Angular white quartzite, schist, granite, micaceous sandstone, quartz
2/2/3/3/3	Angular white quartzite, schist, granite, micaceous sandstone, quartz
2/3/1/1/1	Angular and subangular white quartzite, quartz
2/3/1/1/2	Angular white quartzite, quartz, micaceous sandstone,
2/3/1/1/3	Angular white quartzite, schist, **quartz**,,micaceous sandstone
2/3/1/1/4	No sample of stones
2/3/1/2/1	Angular white quartzite, micaceous sandstone, quartz
2/3/1/2/2	Angular white quartzite, micaceous sandstone, quartz
2/3/1/2/3	Subangular white quartzite, schist, granite, micaceous sandstone
2/3/1/2/4	Angular white quartzite, schist, micaceous sandstone, granite, quartz
2/3/1/3/1	Angular white quartzite, quartz
2/3/1/3/2	Angular white quartzite, micaceous sandstone, buff sandstone, quartz
2/3/1/3/3	Angular white quartzite, micaceous sandstone, buff sandstone
2/3/1/3/4	Angular white quartzite, schist, micaceous sandstone, quartz
2/3/2/1/1	Angular white quartzite, schist, granite, micaceous sandstone, quartz
2/3/2/1/2	Subangular quartzite, white schist, buff sandstone, micaceous sandstone
2/3/2/1/3	Angular white quartzite, micaceous sandstone, quartz
2/3/2/1/4	Subangular white quartzite, schist, micaceous sandstone, quartz
2/3/2/2/1	Angular white quartzite, schist, micaceous sandstone, quartz
2/3/2/2/2	Subangular quartzite, white schist, quartz
2/3/2/2/3	Angular white quartzite, granite, micaceous sandstone, quartz

2/3/2/3/1	Angular white quartzite, micaceous sandstone, quartz
2/3/2/3/2	Angular buff quartzite, schist, quartz
2/3/2/3/3	Angular quartzite, white schist, micaceous sandstone, buff sandstone
2/3/2/3/4	No sample of stones
2/3/3/1/1	Subangular white quartzite, micaceous sandstone, quartz, granite
2/3/3/1/2	Angular white quartzite, schist, micaceous sandstone, quartz
2/3/3/1/3	Angular white quartzite, schist, rounded granite fragments, angular micaceous sandstone, quartz
2/3/3/2/1	Angular white quartzite, quartz
2/3/3/2/2	Angular white quartzite, schist, micaceous sandstone, quartz
2/3/3/2/3	Angular white quartzite, buff sandstone, micaceous sandstone, quartz
2/3/3/2/4	Subangular white quartzite, schist, granite fragments, quartz
2/3/3/2/5	Angular white quartzite, schist, granite, micaceous sandstone, quartz
2/3/3/3/1	No sample of stones
2/3/3/3/2	No sample of stones
2/3/3/3/3	No sample of stones
2/3/3/3/4	No sample of stones
2/4/1/1/1	No sample of stones
2/4/1/1/2	Angular white quartzite, granite, micaceous sandstone, quartz
2/4/1/1/3	Angular white quartzite, some rounded angular micaceous sandstone, quartz, granite
2/4/1/1/4	Rounded and subangular white quartzite, micaceous sandstone, quartz
2/4/1/2/1	Angular and subangular white quartzite, schist, granite, micaceous sandstone quartz
2/4/1/2/2	Angular quartzite, white quartzite, quartz, micaceous sandstone
2/4/1/2/3	Angular white quartzite
2/4/1/3/1	Angular white quartzite, micaceous sandstone, quartz, buff sandstone
2/4/1/3/2	Subangular white quartzite, granite, quartz, micaceous sandstone
2/4/1/3/3	No sample of stones
2/4/2/1/1	Angular white quartzite, schist, micaceous sandstone, granite, quartz, buff sandstone
2/4/2/1/2	Angular white quartzite, schist, quartz, granite, micaceous sandstone
2/4/2/1/3	Angular white quartzite, schist, micaceous sandstone, quartz
2/4/2/1/4	Angular white quartzite, granite, micaceous sandstone
2/4/2/2/1	Angular white quartzite, schist, micaceous sandstone, quartz, buff sandstone
2/4/2/2/2	Angular white quartzite, schist, micaceous sandstone, quartz
2/4/2/2/3	Angular white quartzite, granite, micaceous sandstone
2/4/2/3/1	Angular white quartzite, micaceous sandstone, granite fragments, quartz
2/4/2/3/2	Angular white quartzite, schist, granite, micaceous sandstone
2/4/2/3/3	Angular white quartzite, schist, micaceous sandstone, buff sandstone, pink sandstone
2/4/2/3/4	No sample of stones
2/4/3/1/1	No sample of stones
2/4/3/1/2	Angular white quartzite, schist, buff sandstone, quartz, micaceous sandstone
2/4/3/1/3	No sample of stones
2/4/3/2/1	Angular white quartzite, buff sandstone, micaceous sandstone, quartz
2/4/3/2/2	Angular white quartzite, buff sandstone, schist, micaceous sandstone
2/4/3/2/3	Angular white quartzite, schist, micaceous sandstone, quartz
2/4/3/2/4	Angular white quartzite, schist, granite, micaceous sandstone, quartz
2/4/3/3/1	Angular white quartzite, micaceous sandstone, quartz
2/4/3/3/2	Subangular white quartzite, schist, quartz
2/4/3/3/3	Subangular white quartzite, quartz, buff sandstone
2/4/3/3/4	Subangular white quartzite, schist, micaceous sandstone, quartz
2/4/3/3/5	Subangular white quartzite, schist, micaceous sandstone, quartz
2/5/1/1/1	Angular white quartzite, schist, granite, buff sandstone, micaceous sandstone, quartz
2/5/1/1/2	Angular white quartzite, schist, micaceous sandstone, quartz
2/5/1/1/3	Subangular buff sandstone, granite, quartz, micaceous sandstone
2/5/1/2/1	Subangular white quartzite, micaceous sandstone, quartz
2/5/1/2/2	Angular white quartzite, granite, micaceous sandstone, quartz

2/5/1/2/3	Subangular white quartzite, micaceous sandstone, some rounded
2/5/1/2/4	Angular quartzite, white schist, granite, micaceous sandstone, quartz
2/5/1/3/1	No sample of stones
2/5/1/3/2	Subangular white quartzite, schist, micaceous sandstone
2/5/1/3/3	Rounded granite, white quartzite, micaceous sandstone, quartz
2/5/1/3/4	No sample of stones
2/5/2/1/1	Angular white quartzite, schist, micaceous sandstone, quartz
2/5/2/1/2	Subangular quartzite, white schist, micaceous sandstone, quartz
2/5/2/1/3	Rounded and subangular white quartzite, micaceous sandstone, granite, quartz
2/5/2/2/1	Angular white quartzite, schist, granite fragments, quartz
2/5/2/2/2	Angular white quartzite, schist, micaceous sandstone, quartz
2/5/2/2/3	Angular white quartzite, schist, fine pink sandstone, micaceous sandstone, quartz
2/5/2/2/4	Angular white quartzite, schist, granite, buff sandstone, micaceous sandstone
2/5/2/2/5	Angular white quartzite, schist, micaceous sandstone, quartz
2/5/2/2/6	Angular white quartzite, schist, granite, buff sandstone, micaceous sandstone
2/5/2/2/7	Subangular micaceous sandstone, white quartzite, schist, granite, quartz
2/5/2/3/1	Angular white quartzite, micaceous sandstone, quartz
2/5/2/3/2	Subangular white quartzite, schist, granite, micaceous sandstone, quartz
2/5/2/3/3	Rounded white quartzite
2/5/3/1/1	Angular white quartzite, micaceous sandstone, quartz
2/5/3/1/2	Subangular white quartzite, schist, granite, micaceous sandstone, quartz
2/5/3/1/3	Subangular white quartzite, schist, micaceous sandstone, quartz
2/5/3/2/1	Rounded and subangular white quartzite, granite, micaceous sandstone, quartz
2/5/3/2/2	Angular quartzite, white schist, micaceous sandstone, quartz
2/5/3/2/3	Angular white quartzite, schist, micaceous sandstone, granite fragments
2/5/3/2/4	Subangular white quartzite, schist, granite fragments, micaceous sandstone, quartz
2/5/3/3/1	Subangular white quartzite, micaceous sandstone, quartz, buff sandstone
2/5/3/3/2	Angular quartzite, white schist, micaceous sandstone, quartz
2/5/3/3/3	Rounded quartzite, white schist, quartz, micaceous sandstone, buff sandstone
2/5/3/3/4	No sample of stones

Appendix C

Main stone types identified from Kerrow soil samples

Decreasing abundance from left to right. Shape given is that most commonly occurring.

5/1/1/1/1	Subangular white schist, micaceous sandstone, quartz
5/1/1/1/2	Subangular white schist, pink sandstone, micaceous sandstone, granite fragments
5/1/1/2/1	Subangular white schist, pink sandstone, micaceous sandstone, quartz
5/1/1/2/2	Subangular white and pink schist, micaceous sandstone, quartz, granite fragments
5/1/1/3/1	Subangular white schist, pink sandstone, granite, micaceous sandstone, quartz
5/1/1/3/2	Subangular white schist, pink sandstone, micaceous sandstone, quartz
5/1/2/1/1	Subangular white and buff schist, micaceous sandstone, quartz
5/1/2/1/2	Angular buff micaceous schist
5/1/2/1/3	Solid geology - mica schist
5/1/2/2/1	Subangular white schist, quartz, micaceous sandstone
5/1/2/2/2	Subangular buff sandstone, white schist, micaceous sandstone
5/1/2/3/1	Subangular white schist, granite, quartz, micaceous sandstone
5/1/2/3/2	Subangular white schist, buff sandstone, pink sandstone, micaceous sandstone
5/1/3/1/1	Subangular granite, white schist, buff sandstone, micaceous sandstone, quartz
5/1/3/1/2	Subangular buff sandstone, dark micaceous sandstone, pink sandstone
5/1/3/2/1	Angular white schist, granite, micaceous sandstone, quartz
5/1/3/2/2	Subangular white schist, buff sandstone, micaceous sandstone, granite fragments
5/1/3/3/1	Subangular white schist, micaceous sandstone, quartz, granite
5/1/3/3/2	Angular white schist, micaceous sandstone, granite, quartz
5/1/3/3/3	Solid geology - mica schist
5/2/1/1/1	Subangular white schist, buff sandstone, quartz
5/2/1/1/2	Angular white schist, buff sandstone, micaceous sandstone, granite fragments
5/2/1/2/1	Angular pink and buff sandstone, micaceous sandstone
5/2/1/2/2	Angular micaceous buff schist
5/2/1/3/1	Angular pink and white schist, micaceous sandstone, quartz
5/2/1/3/2	Angular white schist, pink sandstone, micaceous sandstone
5/2/2/1/1	Angular white schist, pink sandstone, dark micaceous sandstone, quartz
5/2/2/1/2	Subangular pink schist, micaceous sandstone, quartz, granite fragments
5/2/2/2/1	Subangular white schist, granite, micaceous sandstone, quartz
5/2/2/2/2	Subangular pink and white schist, granite, micaceous sandstone
5/2/2/3/1	Angular pink and buff schist, quartz, micaceous sandstone
5/2/2/3/2	Subangular white schist, granite, micaceous sandstone
5/2/3/1/1	Subangular white schist, granite, micaceous sandstone, quartz
5/2/3/1/2	Subangular white schist, buff sandstone, pink sandstone, micaceous sandstone quartz
5/2/3/1/3	Solid geology - mica schist
5/2/3/2/1	Subangular white schist, granite, micaceous sandstone, quartz
5/2/3/2/2	Angular white and pink schist, buff sandstone, micaceous sandstone, granite fragments
5/2/3/3/1	Subangular micaceous buff and white schist, quartz
5/2/3/3/2	Subangular white schist, micaceous sandstone, granite fragments
5/3/1/1/1	Subangular white schist, buff sandstone, quartz, micaceous sandstone
5/3/1/1/2	Angular pink and white schist, quartz, granite fragments
5/3/1/2/1	Angular white schist
5/3/1/2/2	Angular white schist, micaceous sandstone, buff sandstone
5/3/1/3/1	No sample
5/3/1/3/2	No sample
5/3/2/1/1	Subangular white schist,
5/3/2/1/2	Subangular White schist, micaceous sandstone
5/3/2/2/1	Subangular white schist, granite, micaceous sandstone, quartz, buff sandstones
5/3/2/2/2	Subangular white schist, micaceous sandstone, black Fe/Mn concretion, granite fragments

5/3/2/3/1	Subangular white schist, granite, micaceous sandstone, quartz
5/3/2/3/2	Angular buff micaceous sandstone, quartz
5/3/3/1/1	Subangular white and pink schist, micaceous sandstone
5/3/3/1/2	Subangular white micaceous schist, buff sandstone, pink sandstone
5/3/3/2/1	Angular buff sandstone, white schist, granite, micaceous sandstone
5/3/3/2/2	Angular pink schist, micaceous sandstone, granite, quartz
5/3/3/3/1	Subangular white schist, micaceous sandstone, quartz
5/3/3/3/2	Subangular white schist, micaceous sandstone, quartz
5/4/1/1/1	Subangular white schist, buff sandstone, micaceous sandstone, quartzite, quartz
5/4/1/1/2	Angular pink and white schist, granite, micaceous sandstone,
5/4/1/2/1	Subangular white schist, granite, micaceous sandstone, quartz
5/4/1/2/2	Subangular white and pink schist, quartz, granite, micaceous sandstone
5/4/1/3/1	Angular white schist, micaceous sandstone, quartz
5/4/1/3/2	Subangular white schist, micaceous sandstone, granite fragments
5/4/2/1/1	Subangulr buff schist, quartz
5/4/2/1/2	Angular white schist, buff sandstone, granite, pink sandstone, micaceous sandstone
5/4/2/2/1	Angular white and pink schist, granite, micaceous sandstone
5/4/2/2/2	Angular white schist, micaceous sandstone, quartz, granite fragments
5/4/2/3/1	Subangular white and buff schist, quartz, micaceous sandstone
5/4/2/3/2	Angular buff schist, pink sandstone, dark micaceous sandstone
5/4/3/1/1	Angular white schist, granite, micaceous sandstone, quartz
5/4/3/1/2	Subangular white schist, micaceous sandstone, granite fragments
5/4/3/1/3	Solid geology - mica schist
5/4/3/2/1	Angular buff sandstone, micaceous sandstone, quartz
5/4/3/2/2	Angular white schist, micaceous sandstone, granite fragments
5/4/3/3/1	Subangular white and buff schist, micaceous sandstone
5/4/3/3/2	Angular white and pink schist, micaceous sandstone, quartz

Appendix D

Main stone types identified from Silpho soil samples

Decreasing abundance from left to right. Shape given is that most commonly occurring.

8/0/1/1/1	Subangular buff sandstone with fossils
8/0/1/2/1	Angular buff sandstone with fossils
8/0/1/3/1	Angular buff sandstone
8/0/2/1/1	Subangular buff sandstone
8/0/2/2/1	Subangular buff sandstone
8/0/2/3/1	Subangular white sandstone
8/0/2/3/2	Angular buff sandstone
8/0/3/1/1	Subangular buff sandstone
8/0/3/2/1	Subangular buff sandstone
8/0/3/3/1	Subangular buff sandstone
8/1/2/1/1	Rounded buff sandstone
8/1/3/1/1	Subangular buff sandstone
8/1/4/1/1	Subangular white sandstone
8/1/6/1/1	Subangular buff sandstone
8/3/1/1/1	Subangular dark yellow sandstone
8/3/1/2/1	Subangular dark yellow sandstone
8/3/1/3/1	Subangular dark yellow sandstone and one rounded porphyry pebble
8/3/2/1/1	Subangular white sandstone and small angular quartz
8/3/2/1/2	Subangular buff sandstone and one shattered round quartzite pebble
8/3/2/2/1	Subangular buff sandstone and small angular quartz
8/3/2/3/1	Subangular buff sandstone
8/3/3/1/1	Subangular buff sandstone
8/3/3/2/1	Subangular buff sandstone
8/3/3/3/1	Subangular buff sandstone
8/4/1/1/1	Angular buff sandstone
8/4/1/2/1	Subangular buff sandstone
8/4/1/3/1	Subangular buff sandstone
8/4/2/1/1	Subangular buff sandstone
8/4/2/2/1	Subangular buff sandstone
8/4/2/3/1	Subangular buff sandstone
8/4/3/1/1	Subangular buff sandstone
8/4/3/2/1	Subangular buff sandstone
8/4/3/3/1	Rounded buff sandstone
8/5/1/1/1	Subangular buff sandstone
8/5/1/2/1	Rounded buff sandstone
8/5/1/3/1	Subangular buff sandstone
8/5/2/1/1	Subangular buff sandstone
8/5/2/2/1	Subangular buff sandstone
8/5/2/3/1	Subangular buff sandstone
8/5/3/1/1	Subangular buff sandstone
8/5/3/2/1	Subangular buff sandstone
8/5/3/3/1	Subangular buff sandstone
8/6/1/1/1	Subangular dark yellow sandstone
8/6/1/2/1	Subangular buff sandstone
8/6/1/3/1	Subangular dark yellow sandstone
8/6/2/1/1	Subangular buff sandstone and one rounded quartzite pebble
8/6/2/2/1	Subangular buff sandstone
8/6/2/3/1	Subangular buff sandstone
8/6/3/1/1	Subangular buff sandstone
8/6/3/2/1	Rounded buff sandstone
8/6/3/3/1	Subangular buff sandstone

Appendix E

Explantory notes on the soil profile description print-outs

Site Name:	"Delnalyn" should read "Delnalyne".
Date:	Refers to day in year, ignores months.
Profile Number:	i.e. 050203 05 refers to the fifth age class 02 refers to the second replicate within that age class 03 refers to the third soil pit within that replicate.
Main plant species:	B.R.C. codes used.
Vegetation type:	The code is that given by Peterken (1967) but an abbreviated version is to be found in the Merlewood R. & D. Paper "Recording Soil Profile Descriptions for Computer Retrieval" by P.J.A. Howard, D.K. Lindley and M. Hornung.
Surface texture:	Terms such as sand loam should ideally read sandy loam, but for the present the computer can only produce the incomplete version.
Solid geology:	The names used here (e.g. Jurassic siliceous sandstone) are not the same as those given in the site description in the report (i.e. Jurassic, Lower Calcareous Grit). This is to allow easier coding of all geological formations by grouping similar rocks of different ages together, and will also help eventually for sorting purposes if all soils formed on, for instance, Jurassic sandstones are required to be printed out.
Major Soil Group:	This code is taken from the soil description by Avery (1973) and now used by the Soil Survey of England and Wales. The criteria for distinguishing soils at the Sub-group and even the Group level have not yet been published. This accounts for many of the Major Soil Group codes consisting of only a single figure (e.g. 6 for podzolic soils). Due to the lack of differentiating criteria it is not possible as yet to name these soils more accurately. However, included in the tables carrying the condensed soil profile description material are both Avery's names (as far as this is possible) together with traditional soil names.

This classification of Avery's, although used only by the England and Wales Soil Survey, has been applied to the three Scottish sites. No classification with codes for the individual soil types is in use in Scotland, and as the Scottish soils fitted into Avery's classification, this was done.

L layer compostion and F layer composition: Again B.R.C. codes are used to describe the plants from which the L + F material was formed.

Nature of F layer: A mistake during data punching assumed that twelve characters were available for nature of F layer. In fact only eight characters were available. In some places the F layer is described as, for instance:-

	MATTEDSP	This should be MATTED SPONGY
Also	MATTEDFI	This should be MATTED FIBROUS
and	MATTED R	This should be MATTED ROOTY

Horizon names: As capital letters only are allowed in the system, some of the horizon names given are somewhat confusing.

The horizon symbol scheme is that shown in Appendix 5 of the R. & D. paper mentioned earlier. To avoid confusion a list is given below of the horizons as printed out by the computer, and their equivalent using both upper and lower case letters.

Computer	Normal	Computer	Normal
OH	Oh	BHG	Bhg
OHE	Ohe	BFX	Bfx
OHEA	Oh/Ea	BSX	Bsx
OHAHE	Oh/Ahe	BHX	Bhx
OHEAHE	Ohe/Ahe	BHBF	Bh/Bf
OHAH	Oh/Ah	BHBS	Bh/Bs
		BBH	B/Bh
EA	Ea	BWBH	Bw/Bh
EA1	Ea1	BSBHBW	Bs/Bh/Bw
EA2	Ea2	BSBHB	Bs/Bh/B
EA3	Ea3	BSB	Bs/B
EAG	Eag	BSXBHX	Bsx/Bhx
EAX	Eax	BSBF	Bs/Bf
EA2X	Ea2x	BSBG BH	Bs/Bg/Bh
EABH	EaBh	BHBF BG	Bh/Bf/Bg
		BSCX	Bs/Cx
AH	Ah	BSC	Bs/C
AHE	Ahe	BS2CX	Bs2/Cx
AEA	A/Ea	BSXCX	Bsx/Cx
AG	Ag	BHBFCX	Bh/Bf/Cx
AHEA	Ah/Ea	BSCX2	Bs/Cx2
ABS	A/Bs	BSBWC	Bs/Bw/C
		BCX	B/Cx
BH	Bh	BC	B/C
BF	Bf	BCG	B/Cg
BS	Bs	BGCG	Bg/Cg
BS1	Bs1	BGHC	Bgh/C
BS2	Bs2		
BH1	Bh1	CX	Cx
BH2	Bh2	CG	Cg
BX	Bx	CGX	Cgx
BSG	Bsg	CGG	Cgg
BG	Bg	CXR	Cx/R
BGG	Bgg	CGXR	Cgx/R

SAMPLE CODE: This ten-digit code includes all details of site, age class, replicate, pit number, and horizon number.

e.g. 0204030201

02 Site No. = Tulchan
04 Age class No.
03 Replicate No.
02 Pit No.
01 Horizon number (starting at top but excluding L + F layers)

Where a horizon is not sampled 0000000000 is inserted.

COLOUR: This is the standard Munsell notation. "N.A." in this position indicates that the colour is not available, and is normally found in cases where the colour is too bright to be found in the charts, for instance Bs and Bf horizons.

STONES: The soil profile recording form does not allow detailed recording of a great variety of stone types and sizes. Only the dominant types are recorded.

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