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THE WOODLANDS OF TELFORD NEW TOWN: THEIR HISTORY, VARIATION AND CONSERVATION

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ABSTRACT

The established woodlands in and around Telford, Shropshire, have been studied to elucidate the relationship between the vegetation and the factors of site, time and management which have influenced it. The history of woodland in the area is reviewed. The woods are shown to be of three main types: ancient, semi-natural; recent, secondary on pit waste; and plantations.

Data from 134 ground layer quadrats (5 × 5 m) from 40 sites were analysed by ordination and indicator species analysis. Environmental characteristics were recorded for each quadrat and are shown to influence the plant communities recognised. A Nature Conservation prescription is presented for the Telford woods based on the results of the analysis. This prescription takes into account woodland management for nature conservation, amenity and educational use.

INTRODUCTION

MUCH of the literature concerning the ecology and conservation of woodlands in Britain deals, perhaps not surprisingly, with ancient, semi-natural woodland. In many parts of the country, however, secondary woodland and planted stands are in the majority and, at a local level, conservationists may be as much concerned with their management as with that of semi-natural woods. In the Telford area, a complex of site-related and historical factors has led to the development of a range of woodland types embracing all three categories mentioned above.

The purposes of the present study are threefold:

(i) to examine variation in the woodland flora throughout Telford New Town and its environs,

(ii) to relate this variation to factors dependent on site, time and management and

(iii) to produce a conservation prescription for management of the woods.

The study area consists of the worked-out East Shropshire Coalfield, the Ironbridge Gorge, the Wrekin and Ercall hills and part of the low-lying Weald Moors (Fig. 1). The southern part of this area was designated as Dawley New Town in 1963, but in 1968 the New Town was extended to include Wellington and Oakengates and re-named Telford after the former Surveyor for Shropshire. The New Town is administered by Telford Development Corporation, which co-sponsored the early part of this study.

The large number of woodlands in the Telford area vary greatly in their ecological and historical characteristics, being influenced by the complex geology, topography and land-use of the region. The Development Corporation has for some years recognised the need to identify the different types of woodland represented and to formulate management prescriptions for the woods with regard to nature conservation, amenity and education.

To reach informed management decisions about the Telford woods, a description and classification of them is required in ecological terms. Apart from more limited schemes, such as those of Rackham (1980), the principal classificatory systems in current use for British woodlands are those of Peterken (1981) and Bunce (1982). The former concentrates on canopy species to produce a list of 39 stand types arranged in 12 stand groups. The latter uses data from all four "layers" of the wood (canopy, shrub, field and ground) to produce 32 plot types; the rest of the scheme (when published) will deal with 16 site-types. Both systems are based on surveys of ancient, semi-natural woodlands and are not easily applied to secondary or planted stands. Many of the Telford stands *are* planted, *are* secondary, or *are* heavily disturbed even where established on apparently ancient sites. Rackham (1980) suggests that the trees in a wood are much less an indication of its ecological "type" than the ground flora since trees have long been influenced by man's use of the woods. Accordingly the classification of the Telford woods used here is based on the ground flora, although other layers were also recorded.

PLATE 1.
General view of mixed woodland developed on acid spoil of the Lightmoor pit mound. Birch and oak are prominent, with hawthorn and sallow less important. Other tree species, including rowan, sycamore and aspen occur elsewhere. Bracken (*Pteridium aquilinum*), creeping soft-grass (*Holcus mollis*), wavy hair-grass (*Deschampsia flexuosa*), and honeysuckle (*Lonicera periclymenum*) are prominent in the field layer.

MATERIALS AND METHODS

Collection and analysis of vegetation data

The general woodland survey of Telford involved the selection of 32 "sites" in 26 woods. Each "site" is a 30 m × 30 m plot which appears visually homogeneous. Within each site three 5 m × 5 m quadrats were placed so as to cover, as fully as possible, the range

PLATE 2.
Field layer on moist nutrient-rich soil at slope bottom of Benthall Edge Wood. At the end of May, when this photograph was taken, the stand is dominated by ramsons (*Allium ursinum*). Other species, of this aspect society, notably dog's mercury (*Mercurialis perennis*) and bramble (*Rubus fruticosus* agg.) become important later.

of variation present. The data from these 96 quadrats, together with 38 quadrats from earlier studies, form the basis for the present analysis. Although a 4 m × 4 m quadrat size was employed for woodland ground flora by the National Vegetation Classification (1977), a 5 m × 5 m quadrat was chosen to conform with other woodland studies in the area (Woodcock, 1978; Sinker *et al.*, 1985). For each quadrat the field layer (including seedlings of woody species) was recorded using a modified Domin cover-abundance scale (National Vegetation Classification, 1977). This method of assessment was chosen for its suitability for recording trailing species such as bramble and *Lamiastrum galeobdolon*.*

A matrix of the quadrat data was constructed showing the relative abundance of each species in each stand. These data were analysed using the methods of reciprocal averaging ordination (Hill, 1973) and indicator species analysis (Hill, Bunce and Shaw, 1975). Both techniques assume that the presence or absence of particular species gives information about the environmental conditions and/or past history of the stands in which they are recorded.

Environmental characteristics

In addition to the Domin scores of field layer species, the canopy and shrub layer species, "total bryophytes", bare ground and leaf litter were also recorded as percentages. Geology

*Nomenclature follows Clapham, Tutin and Warburg (1981) for vascular plants and Watson (1968) for bryophytes.

and altitude were obtained from 1 : 25,000 Ordnance Survey maps; slope and aspect were determined on site using an Abney level and a prismatic compass. Soil pH at 0–4 cm was determined for each quadrat. Five samples were collected, one at each corner of the quadrat and one at the centre, to allow for local variations in soil conditions. Analyses were carried out electrometrically on a soil–water suspension (1 part soil to 2 parts water) within 24 hours of collection of the samples.

Historical studies

The history of the woodlands was investigated by use of both primary and secondary documents. Archives were consulted in the Shropshire County Record Office, the Shropshire Local Studies Library, the Ironbridge Gorge Museum Trust Library and the library at the Headquarters of the Telford Development Corporation. Documents examined include translations of the Domesday Book, Forest Rolls and perambulations (11th–14th Centuries), accounts of ecclesiastical foundations, tithe apportionments, estate records of locally notable families and records of mine closures, as well as many general works relating to Shropshire and, more particularly, to the Telford area.

THE WOODLANDS AND THEIR ORIGINS

Before the data were analysed, the first author (RWT) made a subjective classification of the woodlands in the study area into four types based on land-use history and topography (Fig. 1):

Undisturbed semi-natural	USN
Disturbed semi-natural	DSN
Secondary (on pit mounds)	PM
Plantations	Pl

The geology, topography and history of the area were taken into account in this classification.

Topography

The designated area of Telford New Town covers some 8000 ha and takes the form of a plateau sloping gradually towards the south where it is deeply dissected by the river Severn and its tributary valleys. The plateau extends to the Wrekin in the west and terminates to the north in a scarp slope above the Shropshire Plain. The highest point in the Town is 210 m and its eastern edge is marked by a low ridge. The western end of the Severn Gorge cuts through the limestone of Wenlock Edge, which greatly enhances the flora of the region (Fig. 1). The area studied comprises three main zones:

The low-lying Weald Moors in the north, which are intensively farmed, so that woodland is restricted to shelterbelts, game coverts, other plantations and parkland;

The Coalfield, with its modified topography of open-cast mines and spoil heaps, many of the latter bearing secondary woodland;

The Severn Gorge, its tributaries and the Wrekin–Ercall complex, whose steep slopes bear a mixture of modified ancient and secondary woodland.

Geology

Fig. 2 shows the solid geology of Telford. The Middle Coal Measures, and to a lesser

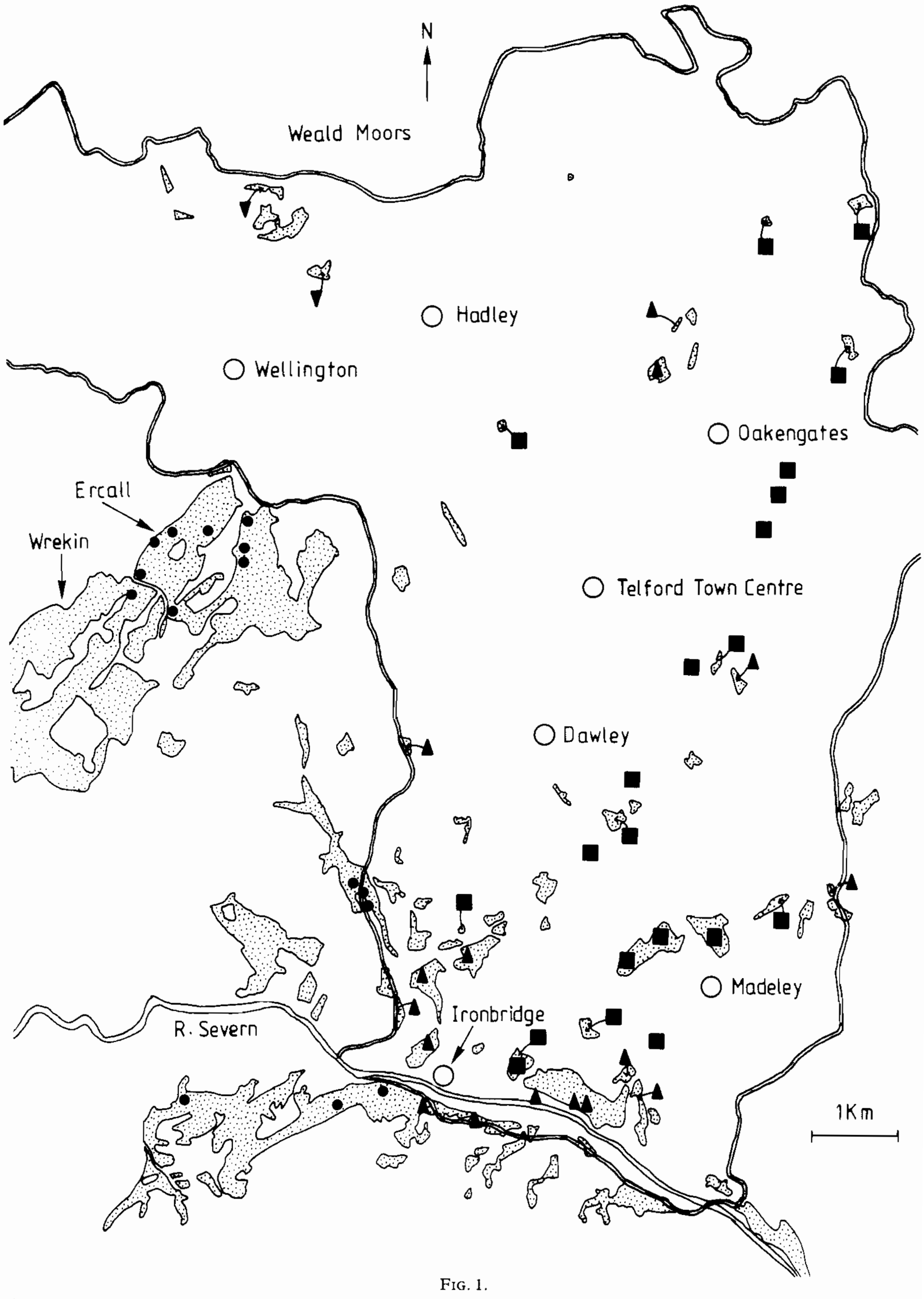


FIG. 1.
Geographical distribution of the sample areas showing the four main types of woodland based on land-use history and topography. ●, Undisturbed semi-natural; ▲, disturbed semi-natural; ■, secondary (on pit mounds); ▼, plantations. The double line shows the outline on Telford New Town. Some small wooded pit mounds (■) are not shown on Ordnance Survey maps as woodlands and thus appear here as isolated symbols.

extent the Upper and Lower Coal Measures, were formerly rich in minerals, yielding not only coal, but ironstone, fireclays and numerous other clays suitable for brick, tile and porcelain manufacture. Both the Silurian and Carboniferous limestones have been extensively mined and quarried. The surface geology of the area is even more complicated than indicated by Fig. 2. Apart from the influence of drift, this results from: extensive mining (which has left large areas of spoil), quarrying, landslip on the steep-sided valleys of south Telford, and large scale earth-moving operations undertaken by Telford Development Corporation.

Soils

Whereas climate determines plant "formations" on a regional scale, edaphic factors, such as pH and drainage, are extremely important in determining plant communities at the local level (Packham and Harding, 1982; Rackham, 1975, 1980). The relationship between solid geology and soils is not usually direct: in much of Britain, woodland soils are often derived from glacial drift (Rackham, 1980). Soils in the Telford area are particularly complex, both in their "natural" state and in the way in which they have been altered by landslip, mining and, more recently, by land reclamation schemes.

The natural soil types of Shropshire are described by Burnham and Mackney (1964); Sinker *et al.* (1985) give a revised terminology. In practice, disturbance is such that there are few parts of Telford where the "natural" soil type still exists. For example, the steep slopes of the Severn Gorge and its tributary valleys consist largely of Coal Measures clays, which are frequently subject to rotational slipping: thus there are areas of secondary woodland in the Gorge growing on slumped clays. Many of the recently established plantation woodlands are on subsoil which may even have been imported from outside the town, and has certainly been moved within Telford during land reclamation schemes. The majority of woods outside the Ironbridge Gorge grow on spoil mounds left from coal and clay mining. These mounds are an intimate mixture of topsoil, subsoil and solid material derived direct from the Coal Measures strata which were mined. The soils on these mounds are usually very thin and do not always correspond closely with the drift or solid geology mapped.

Only on the semi-rural fringe of Telford and at Tick Wood are woodlands found which are on apparently natural soils; even the plantations of north Telford are on soils which may well have been modified during previous agricultural use. Thus the relationships between geology, soils and vegetation in the Telford area are particularly complex, and little reliance can be placed on inferring the geology from the vegetation or *vice-versa*.

WOODLAND HISTORY IN TELFORD

In lowland Britain, man has had a very strong influence on the structure and, to a lesser extent, on the composition of woodlands (Rackham, 1980). Management practices, planting and changing land-use are often at least as important as soil type, microclimate and species availability in determining vegetation types. This is particularly true in an area such as Telford with a long history of industrial land use.

Early history to 1300 AD: The Telford district has an early history similar to that of many other areas in the west and north of Britain: the heavy clay soils of the Midlands were not tilled until about 400 BC when the Celts arrived with their heavy ploughs (Rackham, 1976). The Romans built Watling Street through what is now Telford, but there are few

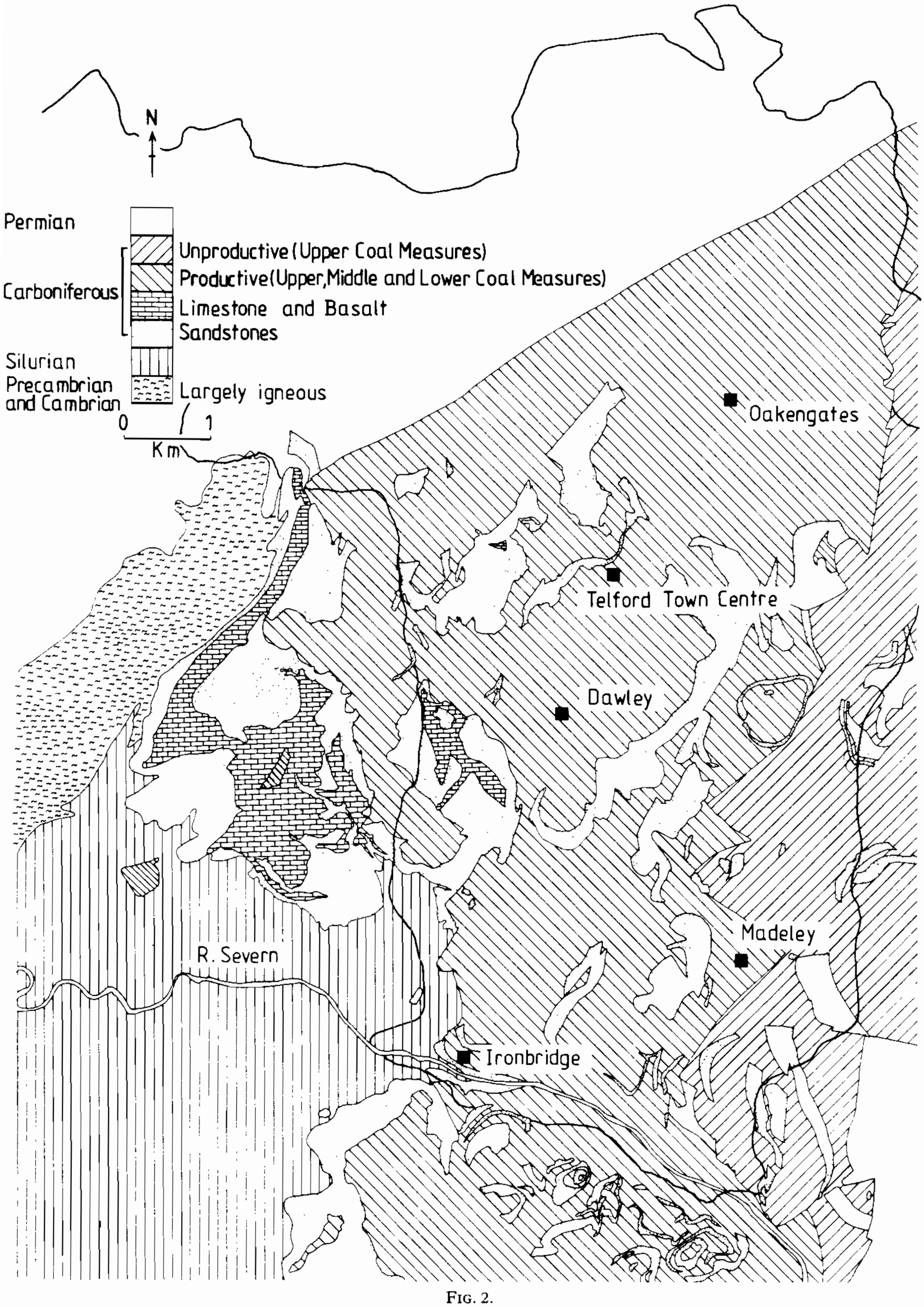


FIG. 2.
The solid geology of the study area, which is extensively faulted and covered by superficial deposits in many places. The outline of Telford New Town is shown by a single line. This figure is based on the 1 : 25,000 Institute of Geological Sciences map for Telford. The Carboniferous sandstones are lithologically similar but of several different ages.

references to their use of woodland. The Saxons moved into the area in the seventh Century, but little evidence remains of their influence save in place names.

When the Normans arrived in Shropshire in 1068, they imparted a higher degree of organisation to the Saxon settlements than these had previously enjoyed. When the Domesday book was compiled in 1086, the Commissioners employed three different methods for computing woodland areas. In Shropshire, the situation is particularly complicated because all three methods were used indiscriminately (Rackham, 1980). Furthermore, Domesday makes little reference to Royal Forests yet the Telford area appears to have fallen largely under the jurisdiction of two such forests. The Shropshire Forest Rolls of 1180 and 1209 and, in particular, the Survey of Shropshire Forests (1235) show the wooded nature of the Telford area, while the Domesday records indicate that two parishes now in Telford had wood for fattening 300 and 400 swine respectively which made them probably among the largest areas of woodland in Shropshire at that time.

The great Perambulation of Shropshire Forests, undertaken at the initiative of Edward 1st in 1300, shows clearly that all of the Forest covering what is now Telford had been "disafforested" by that date, but the Perambulation usefully refers to one wood by a name which can be traced to virtually the same location today.

13th Century to 1709: There are a number of references to industrial activity in the Telford area around the year 1300. From these small beginnings, the district became one of the principal seats of the Industrial Revolution in the 18th Century. A proclamation was issued in 1308 prohibiting the use of coal, in order to protect the interests of timber growers, but once ironmaking began in earnest in the coalfield area, presumably around 1550, commentators suggest that the forest soon became completely denuded, as it was all burnt to make charcoal, the only fuel used for ironmaking at that time. By 1675, Dud Dudley, the first inventor to make practical the use of coal for smelting iron, advocated the change from charcoal as a means of allowing Britain's "devastated" woodlands to regenerate. In this he clearly echoes Evelyn, the diarist and promoter of woodland replanting, who wrote his "Silva" in 1662.

The validity of these claims of wholesale woodland destruction by the iron industry may be questioned. An eighteenth-century description of one Telford wood quoted in Eyton (1856) states that for at least 200 years, since mines of coal and ironstone had been opened up, there was little doubt that the wood was from *time to time* cut down for fusing the iron ore found there. It would surely make sense for the ironmasters, who were well aware of the regenerative powers of native trees when coppiced, to make use of this characteristic, rather than to denude the woods and be left without fuel. Rackham (1980) refutes at some length the argument for 17th Century woodland destruction, suggesting that one author mistakenly interpreted recently coppiced woods as destroyed, and that other authors copied, perpetuating the error. His research shows that the landscape of northern and western Britain was largely complete before 1600 and that each parish had just as much woodland as it could use or support, but no more. The amount of woodland now present in the Severn Gorge is far more than the local inhabitants would have needed for firewood: it is plausible, therefore, that woodland was deliberately maintained and managed (i.e. coppiced) to feed the furnaces of the 17th Century ironworks, although it is known that some secondary woodland is of quite recent origin.

Manor Court Rolls from the area demonstrate the importance attached to separating coppiced woods from those used for pannage. As late as 1801, such control was still carefully exercised in Little Wenlock. Where a coppice was included in a farm, the tenant had pasturage, but immediately before cutting, and for as long as the coppice was young, the Lord had the right to exclude animals, and he then allowed a rent reduction (Victoria County History, 1985).

The Madeley Manorial Survey of 1702 lists all woodland in the Manor: this totalled 2074 acres, valued at a purchase price of £17,366 and a yearly income of £1021. In 1702, the manorial woodland yielded 3369 timber trees and 160 cords of wood (SRO 210/1). This suggests a large area of woodland carefully managed, and would include all the present day woods on the north bank of the Severn Gorge.

1709 to the present: In 1709, the Quaker ironmaster Abraham Darby 1st at last perfected the technique of smelting iron using coke instead of charcoal. Over the next few decades the demand for coppice wood for charcoal gradually fell while the number of coal mines increased rapidly. However, there were still other uses for coppice wood, especially as pit props. At the same time, the intensity of quarrying and other industrial activities increased. On the 1882 Ordnance Survey map of the Severn Gorge there are no fewer than 10 brick and tile works within one mile of the river, and clay eventually became as important a commodity as iron.

From the 1750's onwards, many visitors came to the Severn Gorge to view the wonders of the new industrial age. Their descriptions, both written and pictorial, provide convincing evidence of the wooded nature of the Gorge and its tributary valleys (Trinder, 1977). These, together with the more specific references given earlier, leave little doubt that most of the woodland in the Gorge area has ancient origins, and that most sites have been continually wooded since before records began.

The industrial boom lasted for approximately 150 years in the Telford area: minerals were worked out in Coalbrookdale as early as 1750 (Trinder, 1973), and the ironmasters turned to other areas of the Coalfield. Later still, in the mid-19th Century, deeper mines were opened on the eastern side of the Field. The gradual decline of the industries of the area, brought about partly by exhaustion of raw materials, and partly by the introduction of more efficient processes elsewhere, meant that many industrial sites were abandoned as long as 150 years ago. The particular significance of this for woodlands lies in the large number of relatively small, flat-topped pit mounds left all over the Coalfield after coal and clay extraction. Most of these have been entirely unmanaged, and exhibit a succession of habitats from bare spoil to oak-birch woodlands. The closing dates of mines are well documented (Brown, 1968), but the dates of abandonment of individual mounds are much more difficult to determine.

In addition to management of ancient woodland and development of secondary woodland, there was some ornamental and "amenity" planting. On the rich farmland to the north-west of the Coalfield, woodland clearance was apparently complete by the late 18th Century (Victoria County History, 1985). However, plantations were made in this area between 1805 and 1825 (*ibid.*) and these still exist. At the end of the 19th Century the whole Coalfield area entered a period of economic and social decline which was not arrested until New Town designation.

Indicator Species Analysis

In areas which do not bear natural vegetation, the trees in a wood are much more the product of management and less of the local environment than the ground flora, and hence variations in the latter are more meaningful in an ecological classification of woods. For example, sycamore (*Acer pseudoplatanus*) is very widely distributed in semi-natural and

PLATE 3.
Yellow archangel (*Lamiastrum galeobdolon* ssp. *montanum*), enchanter's nightshade (*Circaea lutetiana*) and sweet woodruff (*Galium odoratum*) in Benthall Edge Wood.

planted woodlands in Telford; the tree species on the pit mounds reflect their colonising ability at least as much as their response to edaphic factors.

Variation in ground flora has, therefore, been used to separate woodland types. It should be noted that the "Groups" derived from the indicator species analysis (ISA) are not discrete types but represent nodes on a continuum formed by all the woodland types in Telford. The Telford woodlands are themselves a "subset" of all the woodland types in Britain; they do not, for example, include birch-pine woods. The ISA was taken to the fourth level of dichotomy (16 groups), but, as some of those groups contained so few stands that meaningful descriptions of them could not be given, the number of groups referred to in this discussion is restricted to eight (i.e. three levels of dichotomy).

Results of the Indicator Species Analysis

Fig. 3 shows the eight Groups of stands derived from the ISA. The analysis yields fairly distinct and identifiable vegetation types, although there is inevitably some overlap between adjacent groups. The first division separates the 134 stands into those with a flora characteristic of dry, commonly acid conditions (Group 1) and those with a flora indicative of damper deciduous woods (Group 0). This separation accords well with similar analyses of woodland quadrats, for example that from the Seckley Ravine, Wyre Forest (Packham and Willis, 1976), and for Shropshire (Sinker *et al.*, 1985). Most of the pit mound quadrats fall into the former category while semi-natural and planted woods are in the latter. *Deschampsia flexuosa* and *Agrostis canina* are the indicators for Group 1, while *Mercurialis perennis, Deschampsia cespitosa* and a number of other species of damp, deciduous woods indicate Group 0.

When considering plant communities in a relatively large number of woods in a restricted geographical area it has proved useful to introduce the concept of characteristic species (Tobin, 1983, p. 62). These are plants which occur in more than 25% of the stands of a particular indicator group and in less than 25% of the stands in any other group. Such species are more useful in separating communities than a complete list of indicator species, each of which may occur in several groups.

Group 0 divides into those stands with a flora characteristic of damp, nutrient-rich or, in certain circumstances, somewhat alkaline conditions (Group 00) and those of drier, rather more acid conditions (Group 01). Group 00 divides into those stands with a flora characteristic of fairly well drained, slightly acid to alkaline soils (Group 000) and those of nutrient-rich soils, often on receiving sites, streamsides, etc. (Group 001). The characteristic species of Group 000 include the calcicoles *Galium odoratum* and *Sanicula europaea*: many of the stands in this group occur either on skeletal soils overlying Silurian limestone, or on the calcareous clays of the Silurian shales and Carboniferous Coal Measures.

Group 001 is characterised by plants often associated with high levels of macronutrients (especially nitrogen and phosphorus) such as *Urtica dioica* (Pigott and Taylor, 1964). All the stands from the woods planted on the fertile, sandy soils of north-west Telford are in this group; *Urtica dioica, Silene dioica* and *Hyacinthoides non-scripta* often occur together here.

Group 01 divides into stands with a flora characteristic of moderately acid conditions, often on quite damp soils (Group 010) and those of drier, somewhat acid conditions (Group 011). *Anemone nemorosa, Luzula sylvatica* and *Stellaria holostea* are common in Group 010. Many of the stands in this group also contain *Oxalis acetosella* and *Lamiastrum galeobdolon* and some exhibit the well-known association of *Pteridium aquilinum, Holcus mollis* and *Hyacinthoides non-scripta,* described by Woodhead (1906) as characteristic of oakwoods on light, dry soils. Group 011 has no characteristic species. It includes a much higher percentage of stands in woods subject to disturbance than the groups previously discussed. This may account for the lack of smaller woodland herbs, and the predominance of species which carpet the ground, e.g. *Rubus fruticosus* agg., *Hedera helix* and *Lonicera periclymenum.* These tend to inhibit the growth of less robust species, by reducing illumination of the woodland floor. Another factor tending to inhibit the growth of smaller herb species is the density of leaf litter (Sydes and Grime, 1981). The disturbed woods contain a high proportion of sycamore in the canopy: the leaf litter from this species is both dense and persistent.

Five pit mounds stands occur in Group 0. Three are in receiving sites at the base of the mounds, where any nutrients leached out from the rudimentary soil tend to collect. The

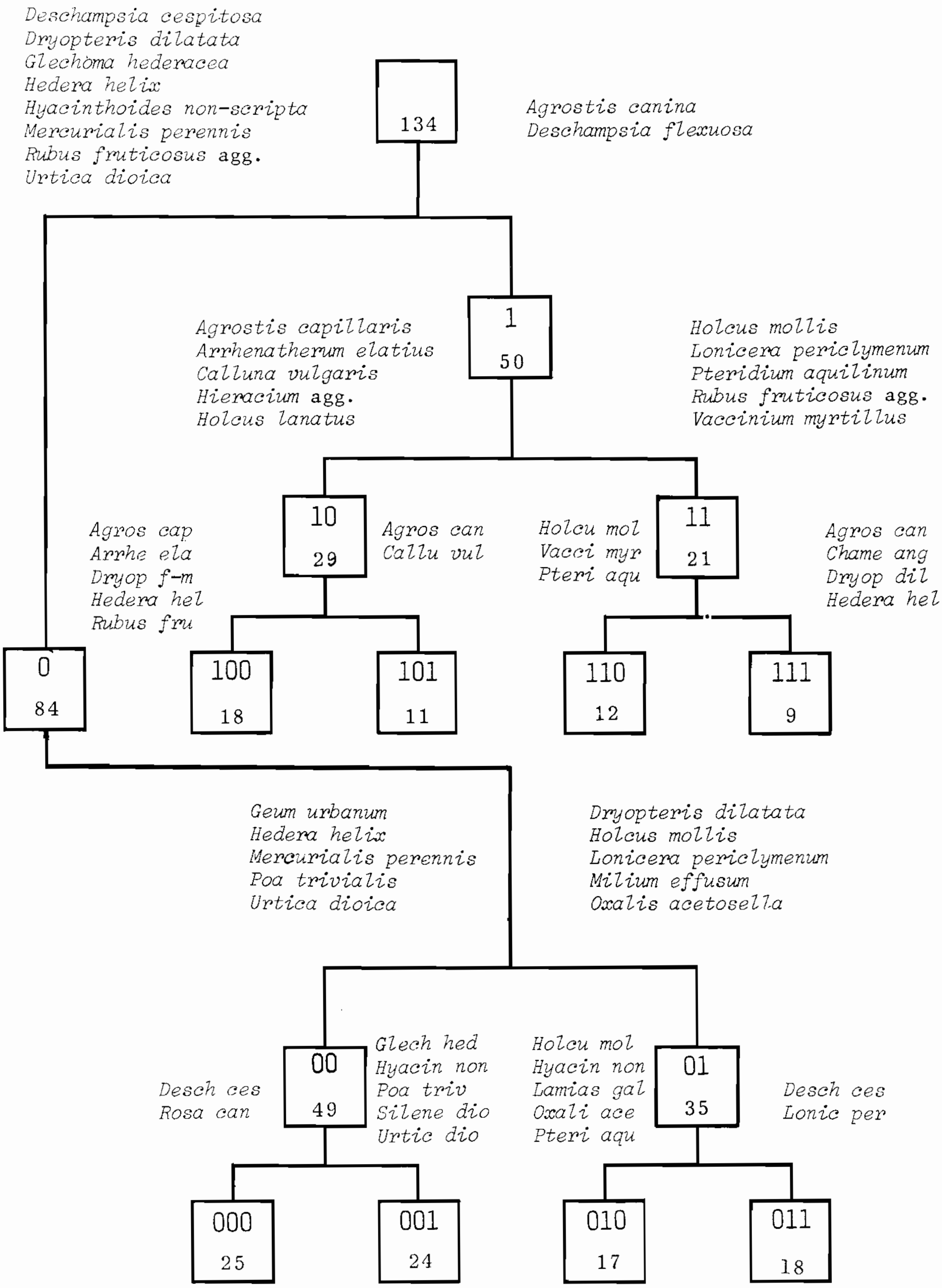


FIG. 3.

Indicator species analysis of 134 5 m × 5 m woodland stands from the Telford region. Group notations are shown in heavy type. The other figures in the squares give the number of stands in each group. The most important division species are shown at each separation, each species being arranged on the side in which it tends to be present. Abbreviations follow the Biological Records Centre card for the Midlands.

other two are on what is apparently the longest-established mound still surviving in Telford; the long time available for colonisation may account for the relative richness of its flora.

Group 1 divides into moderately species-rich stands (Group 11) from the longer-established pit mounds and from dry, acid, semi-natural woodlands, and the species-poor stands of the more recently abandoned mounds (Group 10). Some of the characteristic species for Group 10 are not true lowland woodland species, and tolerate only light shade, *Calluna vulgaris, Arrhenatherum elatius* and *Agrostis capillaris,* for example, being found in relatively open woods.

Group 10 divides into pit mound stands largely dominated by grasses—*Agrostis capillaris, Arrhenatherum elatius* and *Holcus lanatus* (Group 100)—and those on the most rudimentary mound soils, often under a light canopy (Group 101). The dominance of grasses on certain mounds may reflect past management: a number of mounds were grazed once they had developed a vegetation cover. Provided grazing was not too severe, selection would favour grasses, and even when a canopy did develop, other herbaceous species would have to compete with the established grasses. Group 101 includes stands with *Calluna vulgaris,* which is not very shade tolerant and was found to be dying out where oak is replacing birch.

Group 11 divides into stands from the well-established pit mounds (Group 111) and those from the dry, acid, semi-natural sites (Group 110). Group 111 is characterised by *Deschampsia flexuosa, Hedera helix* and *Agrostis canina,* all of which tolerate a quite wide range of soil pH and are fairly drought resistant: the last feature is an important characteristic on the free-draining pit waste soils. Stands in Group 110 are from woods on the natural near-equivalent of these pit wastes—acid, well drained soils on sandstone. The flora of these woods includes *Deschampsia flexuosa, Pteridium aquilinum* and *Vaccinium myrtillus*: the last is especially a plant of heaths.

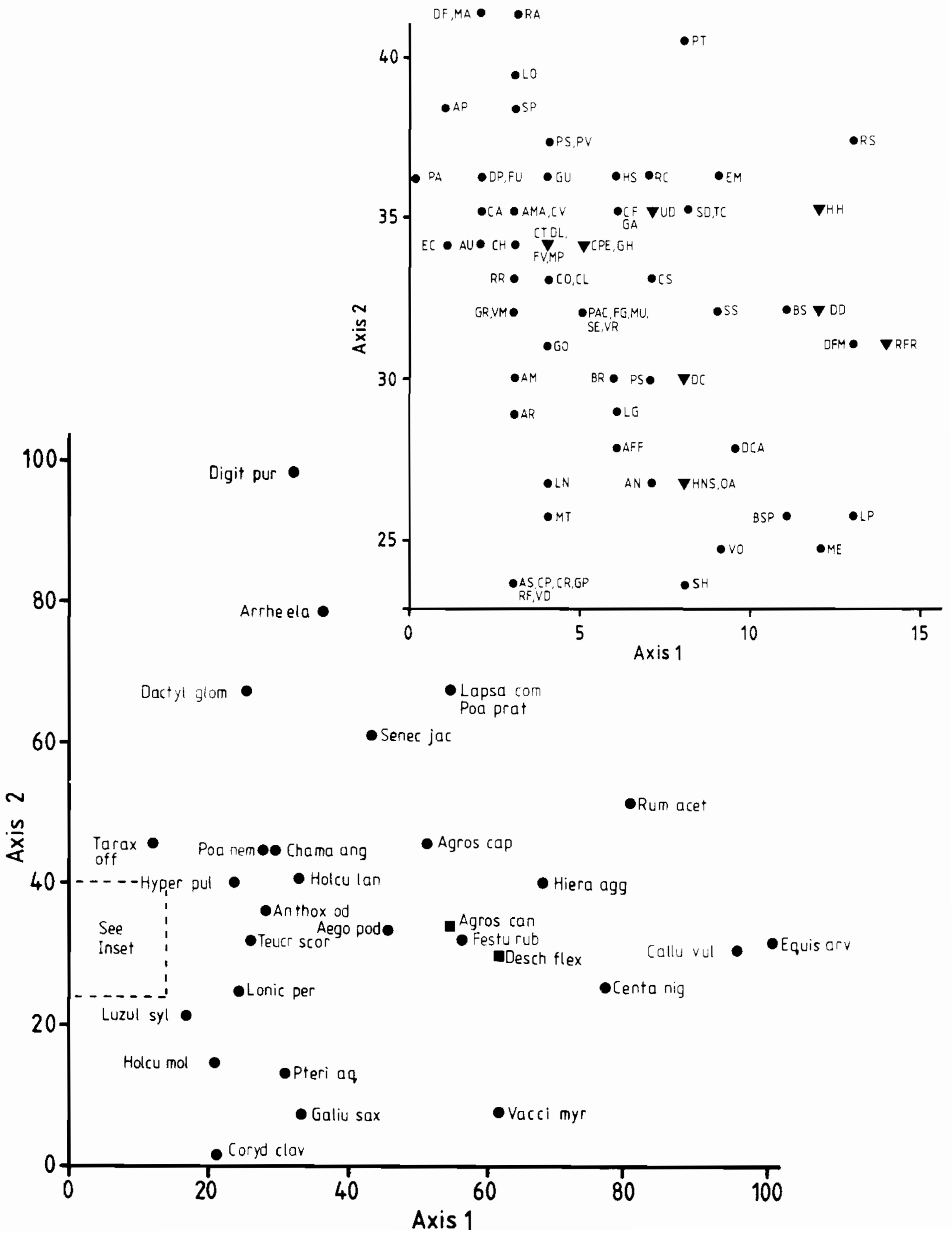
Ordination

In the stand ordination (Tobin, 1983, p. 68), stands from Group 1 are well spread and the four third-level groups (100, 101, 110 and 111) may easily be separated from one another. The stands from Group 0 are much more closely grouped towards the origin. Environmental interpretation of the axes is not straightforward: from left to right along axis 1, soil pH, and to some extent soil moisture, decrease. Axis 2 is less clear: semi-natural stands are grouped closest to the origin, pit mound ones further away.

In the species ordination (Fig. 4) plants characteristic of dry, somewhat acid conditions are grouped in the middle of axis 1 and in the bottom third of axis 2. Most of the remainder of the ordination diagram is occupied by plants which are not true woodland species (e.g. those characteristic of a very open canopy, glades, rides, clearings, etc.). All the true "woodland" species are grouped near the origin of the ordination. Axis 1 separates species characteristic of moist, somewhat acid conditions on the left from those which are favoured by drier, distinctly acid conditions (towards the right). As for the stand ordination, interpretation of axis 2 is doubtful.

Bryophytes

Records were collected for only 44 of the 134 stands and so could not be included in the ISA. However, the distribution of the 31 species of bryophytes which were recorded amongst the 8 groups of the ISA is of some interest. Study of the 12 species which occurred more than twice shows that stands in Group 0 generally contain a greater diversity of


Axis 1
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Digit pur
Arrhe ela
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Lapsa com
Poa prat
Senec jac
Rum acet
Tarax off
Poa nem
Chama ang
Agros cap
Hyper pul
Holcu lan
Hiera agg
See Inset
Anthox od
Aego pod
Agros can
Teucr scor
Festu rub
Desch flex
Callu vul
Equis arv
Lonic per
Centa nig
Luzul syl
Holcu mol
Pteri aq
Galiu sax
Vacci myr
Coryd clav

FIG. 4.

Scatter diagram showing the distribution of the herbs present in the 134 woodland stands from the Telford region. (▼, Group 0 indicator species; ■, Group 1 indicator species; ●, other species).

Key to species

Pteri aq	Pteridium aquilinum	Galiu sax	Galium saxatile
Aego pod	Aegopodium podagraria	Hiera agg.	Hieracium agg.
Agros can	Agrostis canina	Holcu lan	Holcus lanatus
Agros cap	Agrostis capillaris	Holcu mol	Holcus mollis
Anthox od	Anthoxanthum odoratum	Hyper pul	Hypericum pulchrum
Arrhe ela	Arrhenatherum elatius	Lapsa com	Lapsana communis
Callu vul	Calluna vulgaris	Lonic per	Lonicera periclymenum
Centa nig	Centaurea nigra	Luzul sylv	Luzula sylvatica
Chama ang	Chamerion angustifolium	Poa nem	Poa nemoralis
Coryd clav	Corydalis claviculata	Poa prat	Poa pratensis
Dactyl glom	Dactylis glomerata	Rum acet	Rumex acetosella
Desch flex	Deschampsia flexuosa	Senec jac	Senecio jacobaea
Digit pur	Digitalis purpurea	Tarax off	Taraxacum officinalis
Equis arv	Equisetum arvense	Teucr scor	Teucrium scorodonia
Festu rub	Festuca rubra	Vacci myr	Vaccinium myrtillus

Legend to the inset

AFF	Athyrium filix-femina	GP	G. palustre
BSP	Blechnum spicant	GR	Geranium robertianum
DCA	Dryopteris carthusiana	GU	Geum urbanum
DD	Dryopteris dilatata	GH	Glechoma hederacea
DFM	Dryopteris filix-mas	HH	Hedera helix
PAC	Polystichum aculeatum	HS	Heracleum sphondylium
PS	Polystichum setiferum	HNS	Hyacinthoides non-scripta
AS	Agrostis stolonifera	LG	Lamiastrum galeobdolon
AR	Ajuga reptans	LO	Listera ovata
AP	Alliaria petiolata	LP	Luzula pilosa
AU	Allium ursinum	LN	Lysimachia nummularia
AN	Anemone nemorosa	MU	Melica uniflora
AM	Arctium minus	MP	Mercurialis perennis
AMA	Arum maculatum	ME	Milium effusum
BS	Brachypodium sylvaticum	MT	Moehringia trinervia
BR	Bromus ramosus	MA	Myosotis arvensis
CP	Caltha palustris	OA	Oxalis acetosella
CT	Campanula trachelium	PA	Poa annua
CA	Cardamine amara	PT	P. trivialis
CF	C. flexuosa	PS	Potentilla sterilis
CH	C. hirsuta	PV	Prunella vulgaris
CPE	Carex pendula	RA	Ranunculus acris
CR	C. remota	RF	R. ficaria
CS	C. sylvatica	RR	R. repens
CO	Chrysosplenium oppositifolium	RC	Rosa canina
CL	Circaea lutetiana	RFR	Rubus fruticosus agg.
CV	Clematis vitalba	RS	Rumex sanguineus
DF	Dactylorhiza fuchsii	SE	Sanicula europaea
DL	Daphne laureola	SD	Silene dioica
DC	Deschampsia cespitosa	SS	Stachys sylvatica
DP	Dipsacus pilosus	SH	Stellaria holostea
EC	Elymus caninum	SP	Succisa pratensis
EM	Epilobium montanum	TC	Tamus communis
FG	Festuca gigantea	UD	Urtica dioica
FU	Filipendula ulmaria	VD	Valeriana dioica
FV	Fragaria vesca	VM	Veronica montana
GA	Galium aparine	VO	Viburnum opulus
GO	G. odoratum	VR	Viola riviniana

bryophytes than stands in Group 1. A number of species which occur on both sides of the major dichotomy are characteristic of damp soil (e.g. *Pellia epiphylla*), shade (e.g. *Eurhynchium striatum, Mnium undulatum*) and rotting wood (e.g. *Lophocolea cuspidata, Plagiothecium denticulatum*)—conditions typical of Group 0 stands. The Group 1 stands are generally in woods which are dry, fairly open and do not contain much fallen timber; a number of stands bear a ground flora similar to that of an upland oakwood and two mosses which occur almost exclusively in Group 1 stands, *Dicranella heteromalla* and *Plagiothecium undulatum*, are both characteristic of such conditions. Thus the distribution of bryophytes generally accords with that of the ground flora. This is in good agreement with results obtained by Woodcock (1978) who ran ISA for a smaller sample of Telford woodlands with and without bryophytes and found that the lower plants had little effect on the ISA groupings.

CANOPY

Distribution of canopy species among the eight ISA groups is shown in Fig. 5. Twenty-two canopy species have at least 10% cover in one or more stands, but nine of these occur infrequently. Six species are virtually exclusive to Group 0 (*Alnus glutinosa, Acer pseudoplatanus, Corylus avellana, Fraxinus excelsior, Prunus avium* and *Ulmus glabra*). Five of these show "no preference" for any of the subdivisions of Group 0, but *Fraxinus* occurs in 63% of the stands of Group 001, which bear a ground flora indicative of moist, fertile conditions.

Quercus spp. and *Betula* spp. are in all 8 groups of the ISA, but the proportion of *Betula* increases steadily from Group 000 to 111. *Betula* forms only a small component of semi-natural woodlands on somewhat alkaline ranging to mildly acid soils, but becomes predominant on dry, acid sites, and especially on pit mounds where it is a coloniser. Two commonly planted trees, *Castanea sativa* and *Pinus sylvestris*, are restricted to Group 1 stands, which are mostly on pit mounds: both species were planted on coal waste and have tended to spread only into adjacent pit mounds, not into semi-natural sites.

The results of this analysis support the view that the canopy species in semi-natural woodlands are less useful for separating woodland types than the ground flora.

SOIL pH

Analysis of the pH values for each quadrat show a general trend from higher to lower pH from Group 000 to 111 (Fig. 6). The trend is, however, by no means marked and some stands in Group 110 have higher pH than stands in Group 010. This study gives further indication that pH alone should not be used to predict the vegetation on a given soil: many other factors, some edaphic and some management-related, interact to produce the vegetation at a given site. Measurement of the pH of "deep" soil samples at 8–12 cm in the centre of each quadrat shows similar trends to the surface pH.

SPECIES RICHNESS

Analysis of the species diversity of quadrats in each ISA group shows a clear distinction between quadrats in Group 0 and those in Group 1: the former show consistently higher

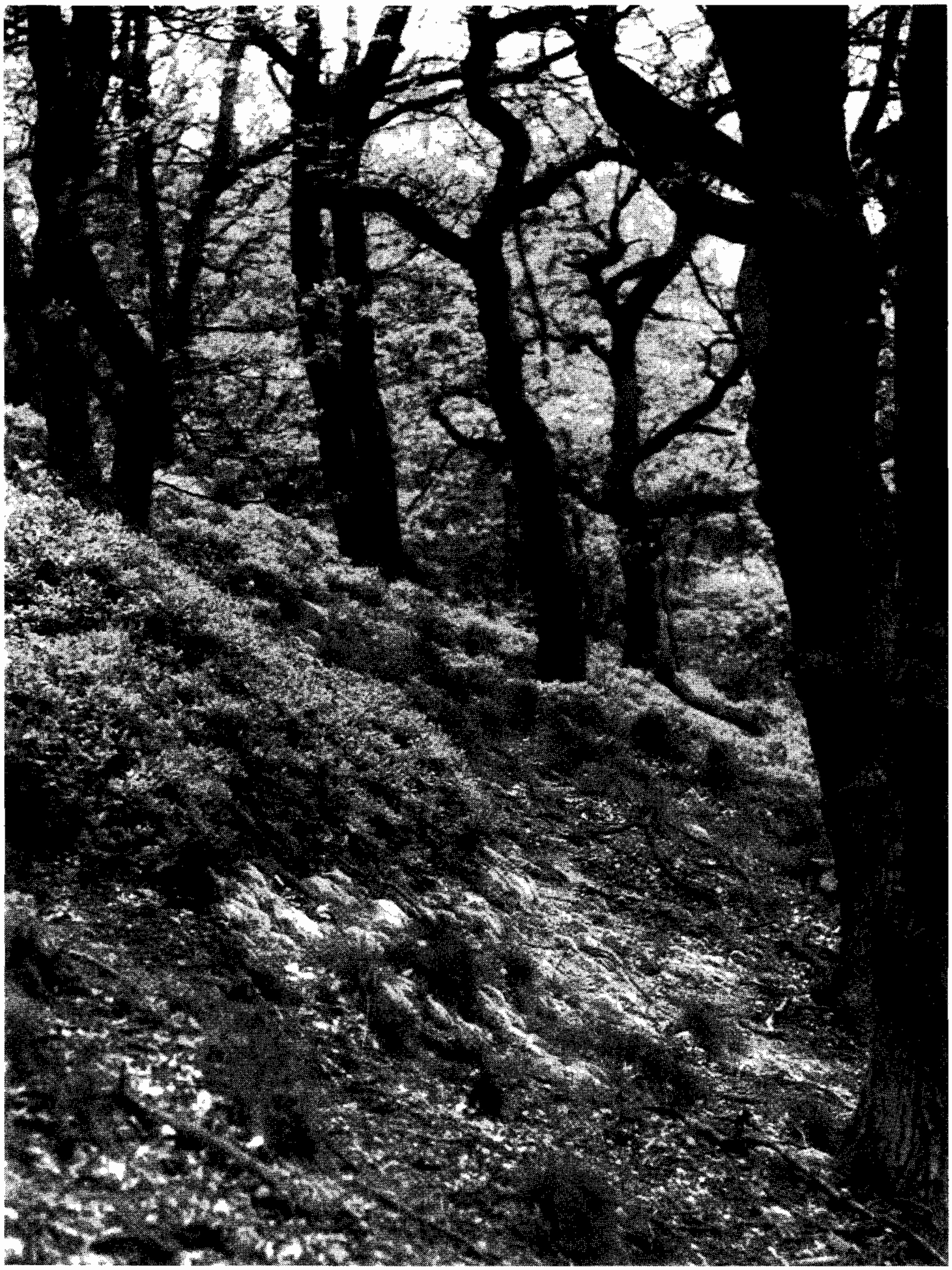

PLATE 4.

Heathy oakwood high on the NW face of the Ercall, near Wellington, with bilberry (*Vaccinium myrtillus*) and wavy hair-grass (*Deschampsia flexuosa*) dominating the field layer. The bryophyte layer is well developed and cushions of *Leucobryum glaucum* can be seen in the foreground.

PLATE 5.

Bird's-nest orchid (*Neottia nidus-avis*) in recently cleared area of quarry in the Silurian Limestone of Benthall Edge Wood. Scrub clearance operations may endanger the long-term existence of saprophytic species such as this.

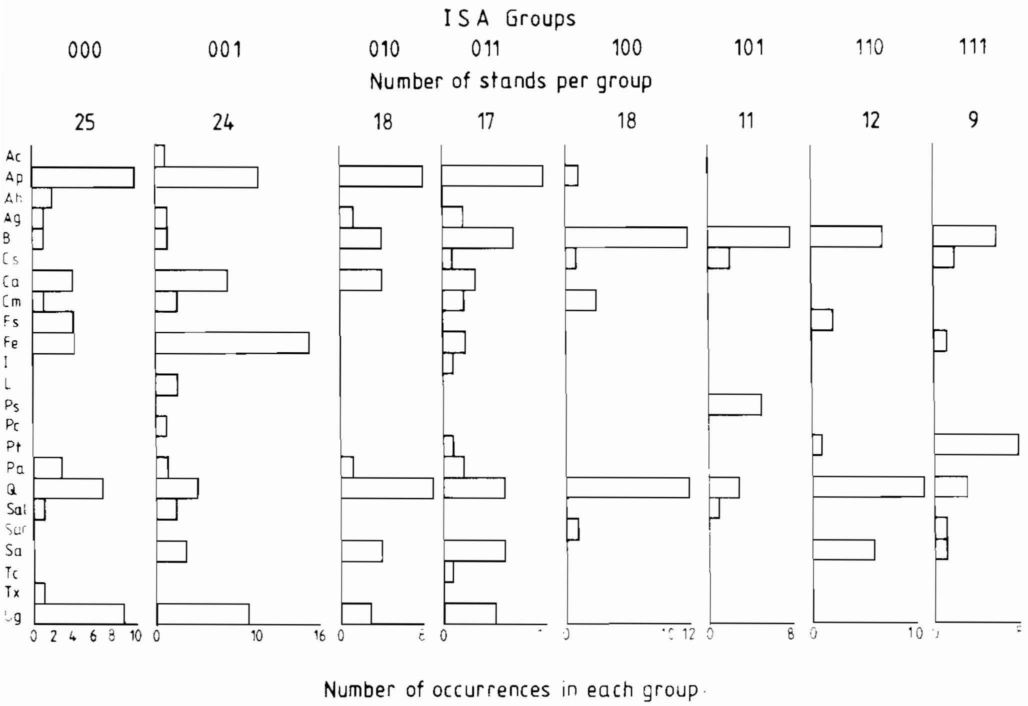

FIG. 5.

Occurrence of canopy species in the major polythetic divisive groups in the 134 woodland stands from the Telford region. The length of each bar is proportional to the number of stands in the group in which the species was present.

Ac	Acer campestre	Fs	Fagus sylvatica	Q	Quercus spp.
Ap	A. pseudoplatanus	Fe	Fraxinus excelsior	Sal	Salix spp.
Ah	Aesculus hippocastanum	I	Ilex aquifolium	Sar	Sorbus aria
Ag	Alnus glutinosa	L	Larix decidua	Sa	S. aucuparia
B	Betula spp.	Ps	Pinus sylvestris	Tc	Tilia cordata
Cs	Castanea sativa	Pc	Populus canescens	Tx	T. × europaea
Ca	Corylus avellana	Pt	P. tremula	Ug	Ulmus glabra
Cm	Crataegus monogyna	Pa	Prunus avium		

diversity of species (means vary between 10 and 12 species per stand) than the latter (means vary between 3 and 6 species per stand [Fig. 6]). This is partly because the soils in Group 0 stands are generally moister and richer in mineral nutrients than those in Group 1 stands, and partly because the majority of Group 0 stands are on ancient woodland sites where colonisation has been possible for much longer than in the recent, secondary pit mound stands.

THE WOODLAND FLORA AND ENVIRONMENTAL FACTORS: CONCLUSIONS

The survey described above demonstrates that the Telford woods are a complex of types, on a variety of soils, of widely varying age and having been subject to a wide range of management regimes. Seven of the ancient woodland "stand types" described by Peterken (1977, 1981) are represented in the study area, the majority of woods being of the ash-wych elm or birch-mixed oakwood types.

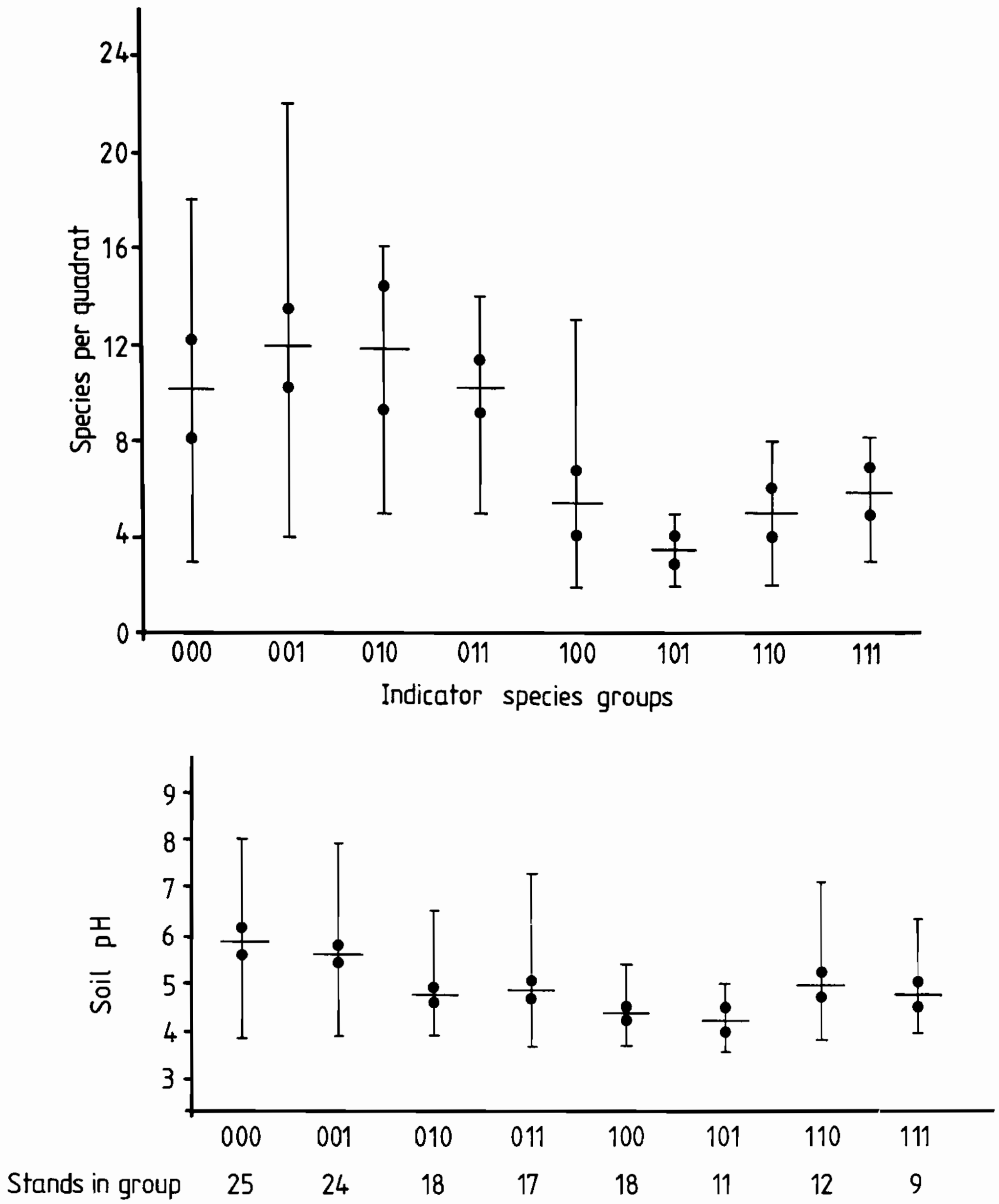

FIG. 6.

Species density (per 25 m^2) and soil pH for the major polythetic divisive groups in the 134 stands from the Telford region. Each vertical bar shows the mean and individual maximum and minimum values found within each group. Ninety-five per cent confidence limits are shown by circles. Soil pH was determined from five samples, all taken at 0–4 cm depth, within each stand.

The ancient woods in Telford contain four main field layer communities, all of which grade into one another. Three of the communities contain *Rubus fruticosus* agg., *Hedera helix*, *Deschampsia cespitosa* and *Dryopteris filix-mas* as dominants. A community on drier, mildly calcareous to moderately acid soils is characterised by *Rosa canina*, *Sanicula*

PLATE 6.
Pendulous sedge (*Carex pendula*), a damp indicator, with male fern (*Dryopteris filix-mas*), wood anemone (*Anemone nemorosa*) and bramble (*Rubus fruticosus* agg.) in Benthall Edge Wood.

PLATE 7.
Ancient oak (*Quercus robur* × *Q. petraea*) regrown from coppiced stool and subsequently subjected to soil erosion. Wellington, near M54.

europaea, *Viola riviniana*, *Galium odoratum* and *Tamus communis* (Group 000). On receiving sites, which are generally moist and rich in macro-nutrients, *Urtica dioica*, *Geum urbanum*, *Poa trivialis* and *Silene dioica* characterise the flora (Group 001). *Mercurialis perennis* is common in both these communities. On damp, fairly acid soils, *Anemone nemorosa*, *Stellaria holostea*, *Oxalis acetosella* and *Lamiastrum galeobdolon* are characteristic (Groups 010 and 011). The fourth ancient woodland community, that of dry, light, fairly acid soils, is much less species-rich than the other three and the dominants include *Deschampsia flexuosa* and *Vaccinium myrtillus* (Group 110).

The plantation woodlands have a ground flora similar to the second community described (Group 001) although they are generally on flat (not receiving) sites. They occur on soils used for agriculture in the past having a fairly high nutrient level. The soils are moderately sandy and freely drained, and *Hyacinthoides non-scripta* is frequent in the plantation woods.

The pit mound woods support three main field layer communities: a grass-dominated one with *Arrhenatherum elatius*, *Agrostis capillaris* and *Holcus lanatus* (Group 100), a more mature type with *Agrostis canina*, *Hedera helix*, *Dryopteris* spp. and *Chamerion angustifolium* (Group 111) and a species-deficient type with *Calluna vulgaris* (Group 101). All but one of the 43 pit mound quadrats contained *Deschampsia flexuosa* as a dominant or abundant species.

The grass-dominated community may have arisen as a result of grazing at some stage in the successional development of the pit mound vegetation, though in some instances grasses may have been the most successful colonisers arising from the seed rain. The more mature type tends to occur on mounds with the densest canopy which have been established longest. The mounds with *Calluna* appear to represent an early successional stage; where a denser canopy is forming on such mounds, *Calluna* is dying out (it will not tolerate heavy shade).

The community types outlined above are useful in describing the woods and in separating different types within the broad historical categories. They do not, however, give a particularly useful classification for formulating conservation prescriptions. This is because of the overlap of community types, the number of species common to the quadrats in Group 0 of the ISA exceeding the number of species which separate or characterise the sub-groups (000, 001, 010, 011).

The ISA fits, in general, with one carried out for woods throughout Shropshire (Packham and Trueman in Sinker *et al.*, 1985). In each instance, the first division places plants characteristic of moderately acid to slightly alkaline soils in Group 0 and those characteristic of more strongly acid soils in Group 1. The Shropshire ISA considers both woodland and scrub communities, so comparison at detailed levels is more difficult. However, associations of species recognisable in the Telford ISA do occur in the Shropshire one. For example, plants characteristic of nutrient-rich soils on receiving sites form separate groups in each ISA. Similarly, the association of *Holcus mollis, Oxalis acetosella* and *Lamiastrum galeobdolon* occurs in each case. Bunce (1982) has also used ISA to analyse 1648 samples from 103 semi-natural woodland sites throughout Britain. This classification gives equal weight to woody species, ground flora and bryophytes which makes direct comparison difficult between Bunce's groups and those derived in the present study. Yet again, however, the first level division has species characteristic of moderately acid to slightly alkaline conditions in Group 0 and those of more strongly acid situations in Group 1. Bunce takes the ISA to five levels of dichotomy, yielding 32 groups. The descriptions of some of these groups bear direct comparison with those of the present study, at least in terms of ground flora. For the geographical reasons mentioned above, the canopy species in a nationwide study will show greater variety than those in a local one.

A Conservation Prescription for the Telford Woods

The final objective of this study is to produce a management prescription for the conservation of the woods examined. Three considerations are involved in developing such a prescription:

(i) the existing state of the woods;
(ii) the desired state of the woods;
(iii) the mechanism for changing the state of the woods from the existing to the desired.

Most of this study has examined in detail the existing ecological state of the woods and related it to factors of site, time and management. Before presenting the prescription for management, the rationale behind nature conservation management of woods is briefly considered here.

Nature conservation may be regarded as a special case of resource conservation (Peterken, 1981). It generally means low intensity of use of the resource (in this case, woodland), but it does not have to mean sustainability of utilisation (e.g. allowing woodland to progress to wood-pasture is valid in nature conservation terms, even though some aspects of the resource—wood and timber (*sensu* Rackham, 1980)—will not all be sustained).

Mature woodland covers 12.5% of the designated area of Telford New Town (Wassell *et al.*, 1981). This is considerably higher than the national mean (8.5%) so that opportunities exist for a variety of prescriptions. In a New Town, or indeed any urban area, nature conservation cannot be considered in isolation from amenity, recreation and education. Moreover, the relationship between visitor numbers, management and community structures worked out for Epping Forest (Layton, 1985, p. 279) appears generally applicable to broadleaved woodlands, whether pollarded or not, and emphasises the need for positive management. Again, the abundance of woodland in the Town should allow for these needs to be met while the best of the semi-natural habitats can still be conserved. Peterken (1981) considers that nature conservation in British woods has the following aims:

(1) to maintain naturally self-perpetuating populations of all native plant species throughout their range;
(2) to maintain adequate examples of all semi-natural woodland communities, including those of trees and shrubs, field layer species, epiphytes and animals together with the soils and other chemical features upon which they depend;
(3) to maintain other features of interest;
(4) to contribute to maintaining an element of wilderness in the British landscape.

To these general aims, the following may be added in a New Town such as Telford:

(5) to enable woods to contribute to the physical identity and landscape structure of the town;
(6) to provide, where appropriate, space for informal recreation, as long as this is not in conflict with (1) and (2) above;
(7) to provide, where appropriate, facilities for study at all levels from primary school to postgraduate research and for the amateur naturalist.

As far as (6) is concerned, the Ironbridge Gorge Woodland Management Group (1973) suggested that certain woods (e.g. Benthall Edge Wood) should be made easily accessible to the public, and the others be kept free from disturbance as far as possible. This idea can well be extrapolated to woods in the whole study area. Some ground flora communities are known to be much more sensitive to trampling than others (Goldsmith, in Warren and Goldsmith, 1974): for instance, the flora of a damp streamside wood will be far more easily damaged than a dry, "heathy" flora. Unfortunately, there is always a risk of vandalism in woods; this reinforces the concept of encouraging people into some woods while restricting access to others.

The relative abundance and to some extent the range of plants and animals which inhabit coppice-with-standards woodland are different from those of high forest (although there is considerable overlap) and it would, therefore, be desirable to allow both types of woodland to develop in Telford. If left unmanaged the recent, secondary, pit mound woods are likely to develop, albeit slowly, into high forest. They will also withstand a moderate degree of public use. Furthermore, because they do not, at present, contain many rare or sensitive species, they can provide a general educational resource without suffering much damage, leaving the more sensitive ancient woods for occasional comparative use and specialist study.

The ancient woods in the area have been subject to varying degrees of disturbance over the decades; some measure of this disturbance is indicated by the frequency of sycamore, which occurs in all of the woods. This tree, although long established in Britain, is not a

Table 1. *A Nature Conservation Prescription for the Telford Woods*

Woodland type	Prescription	Degree of access	Educational use
All	Eliminate or at least reduce sycamore as an alien, invasive species.		
Undisturbed, ancient woods with Group 0 ground flora.	Return to coppice-with-standards management wherever possible. Replace sycamore with native species already present: use saplings derived from the original population if possible. Make no other introductions.	Limited—Benthall Edge Wood and Loamhole Dingle already have nature trails: this should be sufficient.	Serious scientific study: occasional visits from other groups to permit them to contrast this category of woodland with the others.
Undisturbed, ancient woods with Group 1 ground flora.	Evaluate regeneration of oak. Plant with oak, rowan and birch where appropriate. Manage as high forest.	Open: the "heathy" ground flora can withstand considerable public pressure. The absence of a shrub layer means that disturbance to nesting birds should not be serious.	General.
Disturbed, ancient woods with derelict coppice.	Replace sycamore with native species already present. Allow to develop naturally. Some group felling may be necessary to diversify the age structure.	Some open (e.g. Benthall Edge Nature Trail), but keep others with restricted access to minimise disturbance to ground flora, birds, etc.	Those woods with open access: general. Others: serious scientific study only.
Recent, secondary woods.	Allow to develop naturally. Monitor the development of the ground flora on different pit mounds.	To be encouraged in most areas, especially if it relieves pressure on undisturbed, ancient woods.	To be encouraged: indeed further studies should be commissioned on pit mound vegetation.
Plantation woods.	Retain one or two of these woods intact for educational purposes. Otherwise diversify the canopy and shrub layers by group felling and re-planting with appropriate native species.	Open up rides for extracting timber and to admit the public. This will also help to diversify the flora and fauna.	General.

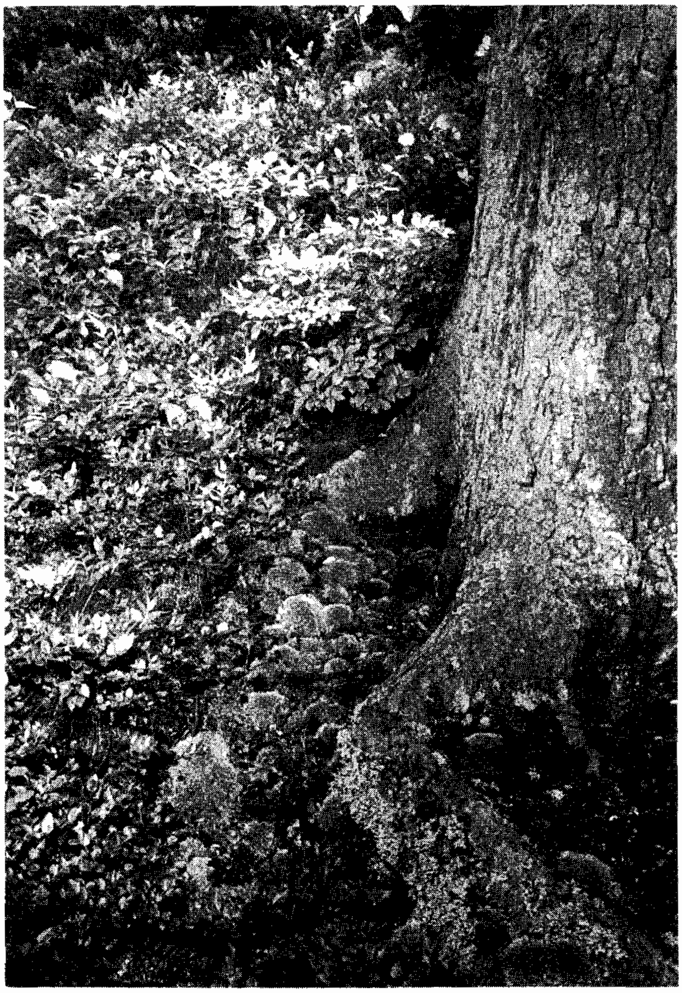

PLATE 8.
Bottom of granophyre slope, Ercall, near Wellington. Pedunculate oak (*Quercus robur*) with field layer of bilberry (*Vaccinium myrtillus*) and wavy hair-grass (*Deschampsia flexuosa*). Cushions of *Leucobryum glaucum* are prominent. Stemflow encourages the immigrant moss *Orthodontium lineare* seen on the right; the oak roots are encrusted with the lichen *Hypogymnia physodes*. *Dicranum majus*, *D. scoparium*, *Polytrichum formosum* and *Plagiothecium undulatum* occur nearby, as do *Calluna vulgaris* and seedlings of *Betula pendula* and *Quercus robur*.

member of the native flora, and is still regarded as an alien component of semi-natural woodland. Its ability to grow on a wide range of established woodland soils, effective dispersal by the wind and its production of very large leaves as a sapling make it a highly competitive, if not aggressive, species. Sycamore presents, therefore, one of the major problems in conservation management plans for the Telford woods.

The prescription in Table 1 relies on a large input of labour (and, therefore, of money). However, in the present economic climate, and for the foreseeable future, there is a large pool of potential labour (the unemployed). Job creation schemes, and opportunities for involving volunteers, combined with a general upturn in public interest in conservation work, have allowed some of the suggested work (e.g. coppicing, ride clearance) to be achieved by the Development Corporation and Local Authority acting as sponsoring and organising agents. The coppicing now being undertaken in Lloyds Coppice under the auspices of the Telford Development Corporation and the Stirchley Grange Interpretation Centre is a notable example of woodland conservation. It has provided timber for use in furniture construction by the Greenwood Trust, a more varied habitat for the local flora and fauna, and a great deal of educational interest.

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APPENDIX

Glossary of plants mentioned in the text

1. Trees and shrubs

Acer pseudoplatanus	sycamore
Alnus glutinosa	common alder
Betula spp.	native birches
Castanea sativa	sweet chestnut
Corylus avellana	hazel
Fraxinus excelsior	ash
Pinus sylvestris	Scots pine
Prunus avium	wild cherry (gean)
Quercus spp.	native oaks
Ulmus glabra	wych elm

2. Plants of the field layer

Agrostis canina	brown bent
A. capillaris	common bent
Anemone nemorosa	wood anemone
Arrhenatherum elatius	false oat-grass
Calluna vulgaris	ling
Chamerion angustifolium	rosebay willowherb
Deschampsia cespitosa	tufted hair-grass
D. flexuosa	wavy hair-grass
Dryopteris filix-mas	male fern
Galium odoratum	sweet woodruff
Geum urbanum	herb bennet
Hedera helix	ivy
Holcus lanatus	yorkshire fog
H. mollis	creeping soft-grass
Hyacinthoides non-scripta	bluebell
Lamiastrum galeobdolon	yellow archangel
Lonicera periclymenum	honeysuckle
Luzula sylvatica	great woodrush
Mercurialis perennis	dogs mercury
Oxalis acetosella	wood sorrel
Poa trivialis	rough-stalked meadow grass
Pteridium aquilinum	bracken
Rosa canina	dog rose
Rubus fruticosus	bramble
Sanicula europaea	wood sanicle
Silene dioica	red campion
Stellaria holostea	greater stitchwort
Tamus communis	black bryony
Urtica dioica	stinging nettle
Vaccinium myrtillus	bilberry
Viola riviniana	common dog violet