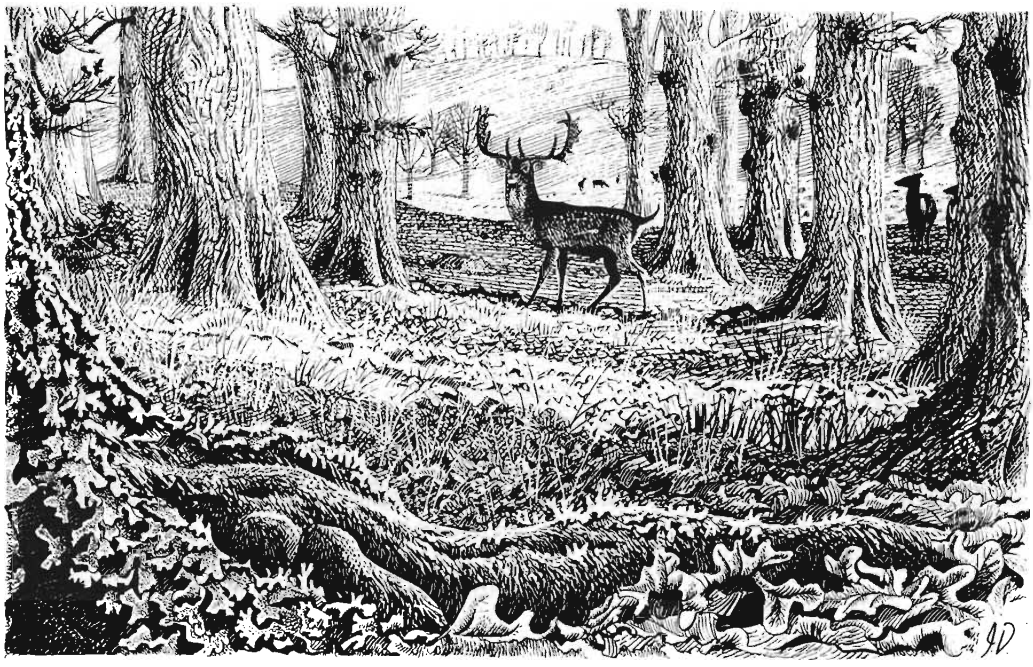
ANCIENT BRITISH WOODLANDS AND THEIR EPIPHYTES



Francis Rose

As a result of much research into both early documents and field evidence, far more is now known about the history of British woodlands than was the case 25 years ago. Rackham's (1976, 1980, etc.) historical studies have been outstanding in this context.

Although the percentage cover of woodlands known to be ancient in Britain is one of the lowest in Europe, the epiphytic flora, particularly of lichens, is outstandingly rich in those areas that have relatively low levels of air pollution, or none at all. This appears to be related to the very large numbers of ancient trees, particularly oaks, *Quercus*, in Britain compared with other western European countries. Some 25 years ago, the great Dutch authority on epiphytes, the late Professor J J Barkman, stayed with me in my home, then in Kent. I drove him across the Weald to the New Forest to see its epiphytic vegetation, and, when I asked him how interesting he had found the excursion, he said of course that the New Forest was outstanding internationally, but he had heard enough beforehand to expect this. However, he added, 'but you didn't tell me that, along our car journey alone, we would see more ancient oaks than there are in the whole of the Netherlands'. At the time, this statement astounded me, but my surveys since then have underlined the truth of his words.

Except in some remote montane areas, and not always even there, comparatively few trees of any great age are to be seen in most parts of western Europe. The extensive forests of France and Germany, though largely on ancient sites and of native tree species, are nearly all managed in such ways that dense stands of trees, often of great height, have developed, but with few open glades. Normally the trees are selectively felled when they are less than 50cm in diameter, so that the potential natural age range is truncated.

Andrew Branson

Ancient wood pasture such as Wood Crates, New Forest, contains some of the richest epiphytic communities in western Europe.

It is now well known, firstly, that rich and diverse epiphytic communities take a long time to develop in broadleaved deciduous forest; and, secondly, that, for their full expression of diversity to be achieved, a combination of adequate light together with some shelter from drying winds is necessary. The richest epiphytic communities occur therefore on old, often formerly pollarded, well-lit tree boles.

The type of British habitats which support richer epiphytic communities

These fall into two rather different categories. Those that may be classified as woodland habitats, and those that may be classified as free-standing trees, in pastures, roadsides, or open parkland.

In Britain three main types of semi-natural woodland (as opposed to plantations) are recognised:

pasture woodlands – long used for grazing by domestic stock or by deer;

high forest – with standard trees close together, ungrazed; and

coppice woodlands – with or without standard trees, regularly cut over and ungrazed.

Pasture woodlands

Woodlands of this type include the following.

Remains of the old Royal Forests

Only the New Forest in Hampshire still retains, any really extensive areas of pasture woodland, owing to the unique political events in its history, though Horner Combe in Somerset still contains some large areas of this type, and small fragments survive elsewhere, particularly at Windsor and Epping Forests and in the Forest of Dean. The Royal Forests, established by the Crown for the conservation of deer, were very extensive from medieval times up to the 17th century, but nearly all have now been cleared of trees or were much modified by replanting as oak woods in the 18th and early 19th centuries. Ironically, much of this planting was to supply the Navy with oak timber for building ships: the use of oak as a major constructional material for ships ceased long before many of the trees matured, iron and steel being used instead. Many of these now 'high forest' types of oak wood still exist in the New Forest, the Dean and elsewhere.

Pollarding – the cutting of a regular supply of small wood at about head height, out of reach of the browsing animals – was widespread in earlier times until the need for naval timber caused this practice to become illegal. There is much evi-

dence that the Royal Forests had extensive open areas of heath or grassland within them. This is certainly true of the New Forest today, which even in the wooded parts has numerous lawns or glades. One must remember that a 'forest' was a legal designation and did not necessarily imply the presence of woodland or even trees.

Old wooded commons

These were very extensive in medieval lowland England, particularly on poorer clay or sandy soils, and were used for grazing the domestic animals of those local people who had rights of common. These rights included (besides grazing) the permission to take dead or fallen wood (estovers), to cut peat if any was present (turbary), and to cut furze, bracken, heather, etc., as was also usually the case in the Royal Forests.

Today, only a few such commons survive. Ebernoe Common in West Sussex is one of the best examples; Burnham Beeches in Buckinghamshire, Binswood in Hampshire, and Whiteparish Common in Wiltshire are others. The practice of pollarding trees was general in wooded commons. Many of the commons that do survive on heavier soils have a much denser tree cover now than in former days. This has resulted from the reduction or total cessation of grazing by stock, leading to extensive regeneration. In some wood-pasture sites, grazing is being re-established (or proposed) for conservation reasons, and new pollards are being created, as at Burnham Beeches.

Medieval deer parks

From Norman times onward, hundreds of deer parks were created in England and Wales. These were much smaller than the Royal Forests (usually only 2-3km^2) and, unlike the forests and commons, they were enclosed by pales – fences erected on earthworks around their perimeters. Brandon (1963) has produced good evidence that, at least in Sussex, many such parks were established on poorer soils that seem to have contained relics of the original wilderness, though some were created on previously farmed land. Contrary to some popular ideas, such parks were created by wealthy landowners not primarily for the sport of the chase, but for the very practical object of providing fresh venison through the winter months. The parks were created at a time when farming husbandry was so inefficient that it was difficult to keep large numbers of domestic stock well enough fed to keep

Ebernoe Common, West Sussex, is an excellent wooded common which is now a Sussex Wildlife Trust reserve.

Andrew Branson

Andrew Branson

Parham Park in East Sussex contains a medieval deer park which has many fine old oaks as well as a herd of Fallow Deer.

up a fresh supply of winter meat. The wealthy had their venison; the poor either managed for a time on heavily salted meat, or went without.

Pollarding was extensively practised in medieval deer parks to provide small wood, as the main function of the trees was to provide some shelter for the deer (or other animals) rather than a supply of large timber. The pollards also provided fodder, especially from Holly, *Ilex aquifolium*, for the deer in winter.

Today, very few deer parks remain with their deer herds still present. Parham and Petworth in Sussex, Knole in Kent, Melbury in Dorset and Inverary in Scotland are among the few intact examples. However, more examples remain of those that have lost their deer and are grazed by cattle or sheep, or just left as wilderness areas. Some of these, such as Whiddon and Arlington Parks in Devon and Brampton Bryan Park in Herefordshire, are still of major importance for epiphytes. Many of the former deer parks were modified into amenity parks by landscaping and planting with groves or clumps of trees in the 'landscape-gardening' era of Kent and Capability Brown.

Pasture woodland in Highland Britain

These were used mainly as winter shelter for deer or sheep from the hills above. Outstanding examples of lichen- and bryophyte-rich woodlands of this type occur at Horner Combe on Exmoor, and by Loch Sunart in the West Scottish Highlands. Some of these woods are on steep slopes or in remote valleys, and some have remained little disturbed even to this day. They form a major 'reservoir' of epiphytic species without equal in Continental Europe, including many internationally rare oceanic lichens and bryophytes.

High forests

Many examples of these are to be found, particularly in the former Royal Forest areas, where they were converted to timber production. Today, they generally contain many mature (but not ancient) trees; the trees are close together, and usually even-aged, owing to planting or selection. They do not generally have the habitat diversity of the pasture woodlands. Areas of grazed closed high forest occur quite widely in the New Forest pasture woodlands.

Coppice woodlands

By far the greatest area of remaining semi-natural woodland in much of lowland England is of the coppiced type, well documented in Rackham (1980) for East Anglia. These woodlands were an essential part of the rural economy in England until the 19th century. Most trees and stands were cut near the base (e.g. Ash, *Fraxinus excelsior*, Hornbeam, *Carpinus betulus*, Sweet Chestnut, *Castanea sativa*, Small-leaved Lime, *Tilia cordata*) or to the base (e.g. Hazel, *Corylus avellana*) at intervals of from five to 20 years, according to local practice, to provide crops of

small-wood poles for a wide range of uses such as fencing, fuel and building construction. Within the woods a limited number of standard trees were retained, well spaced out, to produce larger timbers. Such woodlands needed to be fenced against stock (at least in the first few years) to protect regrowth from being browsed. These woodlands often have rich vascular-plant ground floras whose flowering performance is related to the coppicing cycle. A famous example is Bradfield Woods in Suffolk, which has been regularly coppiced since at least the 13th century and is now a nature reserve, but in many woodlands coppicing has been abandoned this century as uneconomic, and the woods have become very dense and dark.

Sessile oak coppices are still a feature of many upland hillsides in western and northern England and Wales. These were managed primarily to supply bark for the tanning industry.

The epiphytic habitats of the various types of woodland

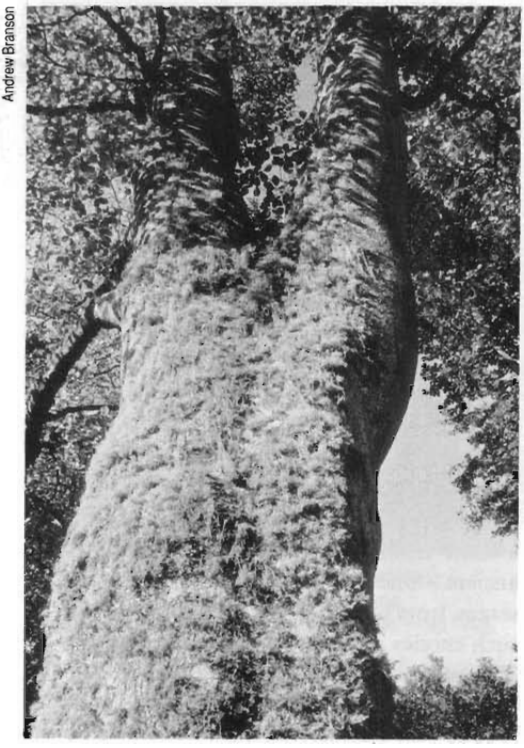
It has become clear as a result of much survey work (Rose & James 1974; Harding & Rose 1986; Rose 1974, 1976, etc.) that the various types of grazed woodland are today the main strongholds of our lichen and bryophyte epiphytic flora and vegetations. It has been argued, particularly in Harding & Rose (1986), that pasture woodlands – although in their present form the result of centuries of human interference – are probably closer in structure, epiphytic flora and invertebrate fauna to the original wildwood than other present-day types of woodland. The reasons for this are:

a pasture woodlands tend to have retained a very wide range of age classes of trees, including ancient ones (the old pollards are admittedly a human artefact, but they do add to the variety of habitats for epiphytes);

b they tend to be a mosaic of open glades, among areas of both open and dense woodland;

c the tree boles are normally well lit, and not heavily shaded by scrub or brambles as is often the case in ungrazed woods.

Much information is now available on the larger fauna of the prehistoric woodlands of Britain, and it is clear that large herbivores, such as Red Deer, *Cervus elaphus*, Aurochs, *Bos primigenius*, and probably wild horses, must have been abundant. These animals would have not only created (and maintained) many glades and open areas in the forests, but in places at least kept down the growth of scrub within them. Most epiphytes, especially lichens, clearly require much light to flourish. Only a few species (mostly the commoner bryophytes) dominate tree trunks in heavily shaded areas. A combination of good illumination and shelter from wind (promoting high humidity for long periods on the trunks) seems essential to many communities and their species.



Andrew Branson

Lichen-covered Beech in a glade at Bramshaw Wood, New Forest.

It is of interest that many other 'woodland' species of plants and animals of woodlands are also largely associated with glade or interface areas, such as a large proportion of the flowering plants, many butterflies and birds. This suggests that the prehistoric wildwood was by no means uniformly dense, but was at least in part a mosaic structure, like much of the present-day New Forest woodlands. If it had not been so, it is difficult to see why evolution should have led to such a preponderance of species associated with

woodland edges and glades. Managed high forests are too uniform and dense to supply the well-lit boles and trees going on to old age and senescence that can be seen to develop rich and diverse epiphytic communities.

Regularly cut coppice woodlands do not develop a wide spectrum of age classes of available trees, and succession is truncated at the time of cutting before mature communities can develop. In coppices, too, the heavy shade is also clearly inhibiting to development of many epiphytes. Even such standard trees as may be present alternate between heavy shading of their boles and drastic drying out, after the coppice is cut.

Epiphytic communities

In the most undisturbed pasture woods – those known from documentation to be the most ancient – one can see all successional epiphytic stages, from second-year twig communities, with such species as *Arthonia punctiformis* and *Mycoporum quercus*, through the *Graphidion* communities (communities can be named after the species that characterise them, in this case the *Graphis* species) of young, smooth-barked trunks with the writing lichens, *Graphis* species, *Arthonia radiata* and *A. cinnabarina*, through younger mature trees with communities of *Parmelia* species, to what seems to be the 'climax' community in West European deciduous woods, the *Lobarion*. This last community contains the larger foliose species, such as the lungwort lichens, *Lobaria pulmonaria* and *L. virens*, also *Parmeliella triptophylla*, *Pannaria* species, *Sticta* species, *Peltigera* species, and *Nephroma* species. Many crustose lichens are also characteristic of the climax *Lobarion* community, together with mosses such as the (common) *Homalothecium sericeum* and *Isothecium myosuroides*, and the (more local) *Pterogonium gracile*, *Leucodon sciuroides*, *Orthotrichum lyellii* and *Zygodon baumgartneri*, and the liverwort *Frullania tamarisci*. This community is best developed on bark with a pH of between 4.7 and 5.5.

In western Scotland, the *Lobarion* community can be found on relatively young mature oak and Ash trees, but in southern England it is today largely confined to older trees, mostly oak and Ash, but also Beech, *Fagus sylvatica*, especially in the New Forest.

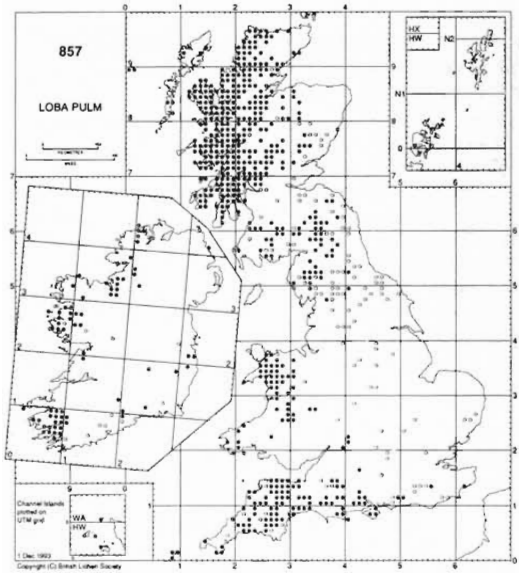
In England and Wales, the *Lobarion* community has a scattered distribution, and is confined entirely to woodlands known or suspected to be ancient, and even there only in areas of Britain that have always been free of major air pollution. Hence the community is no longer found anywhere in the Midlands, east of the Cotswolds and Herefordshire, nor in eastern England north of the Sussex Weald. In the north of England, it is now absent except from the mid-Pennines (Ingleton) northwards, but occurs in Northumbria and Cumbria, away from the old industrial zones.

It has been suggested that the community is a very oceanic one, but old records and herbarium specimens make it clear that, before air pollution became extensive, it occurred very widely through mid-England, eastwards into Cambridgeshire, Suffolk, Essex and Lincolnshire. It also occurred very widely through most of Europe. It is still found today, not only in the lowland forests of western France with an oceanic climate, but also throughout the montane forests of central Europe and southern Europe above about 800m.

Extensive studies of many hundreds of English and Welsh woodlands have revealed that the *Lobarion* community – sometimes, it is true, represented by only a few of its crustose species – shows a striking correlation in its distribution not only with that of ancient woodlands, but above all with ancient pasture woodlands. Apart from the New Forest, nearly all occurrences today are in parks of medieval origin, or their remains, that still contain large old trees. Usually these parks have gladed woodlands that provide both the light levels that seem necessary and the shelter that maintains humidity for much of the year. Sheltered valleys with moist, undrained bottoms seem to be the most favoured sites.

Old wooded commons retain some of the species of the *Lobarion* community, but rarely other than some of the crustose members, such as *Pachypiale carneola*, *Catillaria atropurpurea*, *Arthonia vinosa*, and *Thelotrema lepadinum*.

Managed high forests of native tree species, even those on ancient forest sites, today contain little evidence of the *Lobarion* community. It seems that the relatively even-aged, dense stands of trees provide unsuitable conditions for the



A computer generated distribution map of *Lobaria pulmonaria* from the British Lichen Society national data base, Bradford University. Solid dots are post-1960 records.

Francis Rose

A birch trunk with *Lobaria amplissima, L. pulmonaria, L. scrobiculata, Pannaria conoplea, Sticta limbata, Pseudocyphellaria crocata.* Coille Mhor, Wester Ross 1985.

survival of the community members. Coppice woodlands, even ones long neglected, are normally quite without members of the *Lobarion*. As explained above, the lack of large mature tree boles, and the drastic alternations of the internal environment occasioned by coppicing, seem to inhibit its persistence or recolonisation. One West Sussex woodland, Eastdean Park Wood, has a fine development of the *Lobarion* community locally within it. Though at first sight it appears to be old coppice-with-standards woodland, there is a relatively open stand of large oaks and Ash trees in its centre where the community occurs. However, investigation of its history showed it to have been a medieval deer park that was only partly converted into a coppice-with-standards structure in more recent times.

Another epiphytic community, associated with ancient trees rather than ancient woodland, is the *Lecanactidetum premneae* association. This is normally found only on trees 250 to 300 years old or more, mainly old pollard oaks, whose bark has become dry and brittle with age. This community contains only lichens and no bryophytes. The major species in southern Britain is the crustose *Lecanactis premnea* with black, drum-shaped fruiting bodies to 1mm in diameter. Other members of this distinctive community include *L. lyncea* with a chalk-white thallus, *L. amylacea*, and *Opegrapha prosodea*, which has narrow elongate black fruits.

This *Lecanactidetum* community seems to represent a sort of 'post-climax' association (to use Tansley's term) occurring only in the late stages of the life of a tree. At this stage the oaks (or rarely Beeches) are often hollow, sometimes with fragmentary boles, but historical evidence makes it clear that such trees, if left alone, may last for centuries in this state. Individual trees have been identified in some parks which appear from descriptions in old documents to have changed little in appearance over the last two or three hundred years. Such trees, of course, are usually extremely important also for their saproxylic fauna, mainly of beetles, that live in their slowly decaying heartwood. This community occurs in ancient forest, as in the New Forest, but is able to persist on more or less isolated trees in very dry, open conditions in the remains of some former deer parks even in Norfolk and Suffolk.

Trees in former deer parks that have been 'landscaped', or planted with open stands of trees, are not without epiphyte interest. The same is true also of old planted avenues of trees, including alien trees such as the hybrid Lime, *Tilia* × *vulgaris*, or Sycamore, *Acer pseudoplatanus*. Formerly, old elm, *Ulmus*, avenues were of considerable interest, too, but sadly these are a fea-

ture of our landscape that has almost disappeared. Where such trees have a naturally basic bark of high pH, such as elms, Ash or Sycamore (or even Tulip Tree, *Liriodendron tulipifera*), or where the bark has become impregnated with dust containing elements from animal urine or excreta in places where animals are pastured, then a colourful community known as the *Xanthorion* can be found. In the days of extensive permanent pastures free of inorganic fertilisers and herbicides, and also of extensive horse traffic on our roads, this *Xanthorion* community was very general on mature roadside, meadow and pasture trees, as well as in parks. It contains, besides the orange foliose lichen *Xanthoria parietina* (also found on walls and roofs), such grey or white foliose lichens as *Physcia aipolia*, *P. adscendens*, *P. tribacia*, *Physconia grisea*, *Diploicia canescens*, *Anaptychia ciliaris*, and the shrubby grey lichens of the genus *Ramalina*. Also present are mosses such as *Leucodon sciuroides* and *Homalothecium sericeum*. This community requires a bark pH of about 6.0 or above. The *Xanthorion* seems to be the natural climax community of open, summer-droughted lowland Mediterranean forests, where there is a heavy accumulation of nutrient-rich dust in summer, and perhaps in prehistory was not a feature of more northerly European woodland.

Finally, we should mention the highly calcifuge community of exposed upland woodlands in western Britain where the bark is leached by heavy rainfall. This is dominated by the silvery-grey *Parmelia laevigata* (with *P. taylorensis*, *P. endochlora*, *P. sinuosa*, *Ochrolechia tartarea*, *O. androgyna*, *Sphaerophorus globosus*, *Usnea filipendula* and *Cladonia* species). The bark pH of oaks (and birches, *Betula*) in this community ranges between 3.5 and 4.5. It is a strongly oceanic community, and on the lower parts of the trunks (which are less exposed to periodic desiccation) rich bryophyte communities occur, including such species as *Plagiochila spinulosa*, *P. punctata*, *Bazzania trilobata*, *B. tricrenata*, *Scapania gracilis*, *Douinia ovata* and *Leptoscyphus cuneifolius*. This community is at present extending its range down to sea level in some areas west of Glasgow (Cowal) where acid rain is reducing bark pH in areas where the *Lobarion* (from older documentation) was formerly the dominant epiphytic community in the lower, lochside forests.

Table 1 Lichen epiphytes used to calculate the Revised Index of Ecological Continuity (RIEC) (Rose 1976).
(Nomenclature as in Purvis *et al.* 1993)

Arthonia vinosa
Arthopyrenia ranunculospora
Biatora (Catillaria) sphaeroides
Catillaria atropurpurea
Degelia (Parmeliella) plumbea or *Parmeliella triptophylla*
Dimerella lutea
Enterographa crassa
Lecanactis lyncea
Lecanactis premnea
Lobaria amplissima
Lobaria pulmonaria
Lobaria scrobiculata
Lobaria virens
Loxospora (Haematomma) elatina
Nephroma laevigatum
Pachypiale carneola
Pannaria conoplea
Parmelia crinita
Parmelia reddenda
Peltigera collina
Peltigera horizontalis
Porina leptalea
Pyrenula chlorospila or *P. macrospora*
Rinodina isidioides
Schismatomma quercicola
Stenocybe septata
Sticta limbata
Sticta sylvatica
Thelopsis rubella
Thelotrema lepadinum

Lichens as indicators of ecological continuity

We have suggested that the species-rich *Lobarion* community was the natural-climax epiphytic community of our prehistoric wildwood in most places. If this is so, then, outside the remoter areas of Scotland, it is likely today to be a relict community. It seems able to maintain itself in the very limited number of suitable sites where it still occurs when left undisturbed, but it seems to have little or no ability to colonise new sites. In the New Forest, oak plantations of 150 years or more of age, even adjacent to known ancient woods, show little penetration by *Lobarion* species except for some of the crustose species mentioned above. Interestingly, the oldest oak plantation in the New Forest, South Bentley Wood, which was planted after felling in about 1700, has some penetration of such species as *Lobaria pulmonaria* and *Rinodina isidioides*

Table 2 Lichen epiphytes used to calculate the New Index of Ecological Continuity (NIEC).

Agonimia octospora
Arthonia astroidestra
Arthonia vinosa
Arthopyrenia antecellans
Arthopyrenia ranunculospora
Arthothelium ilicinum
Bacidia biatorina
Biatora (Bacidia) epixanthoides
Biatora (Catillaria) sphaeroides
Biatorina atropurpurea
Buellia erubescens
Cetrelia olivetorum
Chaenotheca species (count one only but not *C. ferruginea*)
Cladonia caespiticia
Cladonia parasitica
Collema furfuraceum or *C. subflaccidum*
Degelia (Parmeliella) atlantica or *D. (P.) plumbea*
Dimerella lutea
Enterographa sorediata
Heterodermia obscurata (W)
Lecanactis amylacea
Lecanactis lyncea
Lecanactis premnea
Lecanactis subabietina
Lecanora jamesii
Lecanora quercicola
Lecidea sublivescens
Leptogium cyanescens
Leptogium lichenoides
Leptogium teretiusculum
Lobaria amplissima
Lobaria pulmonaria
Lobaria scrobiculata
Lobaria virens
Loxospora (Haematomma) elatina
Megalospora tuberculosa
Micarea alabastrites or *M. cinerea*
Micrea pycnidiophora
Nephroma laevigatum
Nephroma parile
Ochrolechia inversa
Opegrapha corticola
Opegrapha prosodea
Pachyphiale carneola
Pannaria conoplea or *P. rubiginosa*
Parmelia crinita
Parmelia reddenda
Parmeliella jamesii
Parmeliella triptophylla
Peltigera collina
Peltigera horizontalis
Pertusaria multipuncta
Pertusaria velata
Phaeographis dendritica or *P. inusta* or *P. lyellii* (SE England only)
Phyllopsora rosei
Polyblastia allobata
Rinodina isidioides
Schismatomma niveum
Schismatomma quercicola or *Pertusaria pupillaris*
Stenocybe septata
Sticta limbata
Stitica fuliginosa or *S. sylvatica*
Strangospora ochrophora
Thelpsis rubella
Thelotrema lepadinum
Usnea ceratina
Usnea florida
Wadeana dendrographa
Zamenhofia coralloidea
Zamenhofia hibernica

Bonus species
Anaptychia ciliaris (count in Devon only)
Arthonia arthonioides
Arthonia anglica
Arthonia zwackhii
Arthonia anombrophila
Bacidia circumspecta
Bacidia subincompta
Catillaria laureri
Caloplaca lucifuga
Collema fragrans
Collema nigrescens
Collema subnigrescens
Cryptolechia carneolutea
Gyalecta derivata
Leptogium burgessii
Leptogium cochleatum
Megalaria grossa (in S England)
Opegrapha fumosa
Opegrapha multipuncta
Pannaria mediterranea
Pannaria sampaiana
Parmelia arnoldii
Parmelia horrescens
Parmelia minarum
Parmelia sinuosa
Parmelia taylorensis
Parmeliella testacea
Pseudocyphellaria crocata
Pseudocyphellaria thouarsii agg.
Ramonia species
Schismatomma graphidioides
Sphaerophorus globosus (S England only)
Spaerophorus melanocarpus (S England only)
Sticta dufourii
N.B. Pairs (either/or) are alternatives – count only one if both occur

where it adjoins the ancient Anses Wood (which has the *Lobarion*). This has spread for up to 200m into the planted wood – not very far in nearly 300 years!

These points suggest that one might be able to construct an 'Index of Ecological Continuity', using lichens, which might enable one to assess the probability of a particular wood (with mature trees of native species) being ancient or not. I have produced several indices of this kind, and they seem to work quite well. Perhaps the most useful is the Revised Index of Ecological Continuity (RIEC: Table 1). This is based largely on those *Lobarion* or *Lecanactidetum* species found in the New Forest and lowland English parklands. It contains 30 species, but not all of them have identical geographic distributions in Britain, so it was considered reasonable to regard the presence of at least 20 out of the 30 species in the list (20 species giving an index value of 100%) as a possible indication that a non-coppiced woodland with low air pollution was of, at least, early medieval origin at a time when woodland was rather more continuous and dispersal of species was easier. The concept is a purely statistical one. The presence of only a few of the species in the Index list signifies little, but I would argue that the more of these exacting and poorly mobile species that occur in a site, the greater is the probability that the woodland (or those parts of it containing the RIEC species) is ancient.

Recent studies by Rackham (1980) suggest that the 'wildwood' had largely disappeared over much of lowland southern England by Roman times. Hence, the period when easy dispersal of these poor colonising species was possible may be much earlier than was once thought. If this is so, then very high values of the RIEC at a site

Table 3 Selected woodland sites in Britain, showing (a) total number of lichen taxa in each site (approximately 1km^2); (b) values of the Revised Index of Ecological Continuity based on 30 taxa; (c) values of the New Index of Ecological Continuity based on 70 taxa. Adapted from Rose (1992).

Name	a	b	c
i) Ancient woodland areas in the New Forest (10 richest sites)			
Mark Ash Wood	178	115	44
Bramshaw Wood	166	115	45
Great Wood	148	105	41
Sunny Bushes	103	90	31
Redshoot Wood	148	100	40
Stricknage Wood	146	100	43
Busketts Wood	175	105	43
Hollands Wood	140	100	41
Wood Crates	170	95	40
Stubbs and Frame Wood	168	110	49
ii) Relatively intact medieval deer parks			
Arlington Park, Devon	213	130	45
Dunsland Park, Devon	163	115	38
Whiddon Park, Devon	163	100	36
Boconnoc Park, Cornwall	191	145	50
Trebartha Park, Cornwall	162	130	38
Mells Park, Somerset	143	80	23
Melbury Park, Dorset	218	110	43
Lulworth Park, Dorset	150	75	29
Longleat Park, Wiltshire	159	90	34
Parham Park, Sussex	190	65	26
Eridge Park, Sussex	185	95	30
Ashburnham Park, Sussex	172	80	27
Brampton Bryan Park, Hereford	176	65	22
Dynevor Park, Dyfed	137	85	30
Dolmelynllyn Park, Gwynedd	157	125	44
Inverary Park, Strathclyde	134	90	29
Drummond Park, near Crieff, Tayside	162	65	21
Cawdor Castle, near Nairn, Highland	131	60	13
iii) Old Royal Forests other than the New Forest			
Savernake Forest, Wiltshire	165	85	28
Windsor Forest, Berkshire	75	20	3
Wychwood Forest, Oxfordshire	128	40	9
Epping Forest, Essex	38	10	0

Name	a	b	c
iv) Mature hardwood plantations, mainly of oak: *18th-century plantation, # adjoins ancient woodland			
Dalegarth Wood, Cumbria*	68	20	8
Nagshead Inclosure, Forest of Dean	16	0	0
Cranford Cross, Devon	24	5	2
Brockishill Inclosure, New Forest #	80	50	14
Pondhead Inclosure, New Forest	33	30	8
South Bentley Wood, New Forest*#	82	70	22
v) Medieval wooded commons with old pollards			
Ebernoe Common, Sussex	111	50	15
The Mens, Sussex	75	50	12
Burnham Beeches, Buckinghamshire	94	35	6
vi) Ancient woods, formerly pastured deer park, but now modified to coppice with standards although retaining some stands of ancient trees in places			
Eastdean Park Wood, Sussex	110	70	18
Pads Wood, Sussex	74	55	16
vii) Woodlands managed as coppice (with some standards) for many centuries; standards not very old			
Bradfield Woods, Suffolk	15	0	0
Brenchley Wood, Kent	44	5	0
Nap Wood, Sussex	54	25	5
Hayley Wood, Cambridgeshire	35	5	0
Foxley Wood, Norfolk	15	5	1
Park Coppice, Coniston, Lancashire	16	0	0
viii) Ancient pasture woodlands in upland Britain; few pollards present, except locally			
Horner Combe, Somerset	176	125	45
Barle Valley, Somerset	170	140	46
Camasine Wds, Loch Sunart,H'land	227	120	43
Walkham Valley, Devon	122	85	27
Low Stile Wood, Cumbria	219	130	51
Yew Scar, Gowbarrow, Cumbria	117	100	30
Coed Crafnant, Gwynedd	159	125	47

may indicate some ecological continuity with a period much earlier than Anglo-Saxon times.

In recent years, I have tried to extend this concept to woodlands on the Continent in western Europe. With some modification of the species list, to allow for less oceanic climates inland, the concept works very well in unpolluted areas in France, Italy, north Spain, south Germany and southern Scandinavia. I am preparing indices to cover various parts of western Europe, and also regional indices for various parts of Great Britain. An index designed for the more continental climate of the ancient oak woods of north-east Scotland seems to work very well in the old oak woods of Jutland in Denmark. The standard RIEC works well through most of western France and into north-west Spain, and also in Tuscany in Italy, which has a rather oceanic climate. Dr B J Coppins and myself have also designed a 'Pinewood Index' for the assessment of the relics of the Scottish Caledonian Forest. The suites of species occurring in the Caledonian Forest relics are, in general, very different from those of the more lowland broadleaved forests, owing to the very different nature of Scots Pine, *Pinus sylvestris*, bark and wood. However, broadleaved trees do occur in the Caledonian Forest (birch, Rowan, *Sorbus aucuparia*, Holly, Alder, *Alnus glutinosa*, and some oak in valley sites), so there is some degree of overlap. The Pinewood Index highlights very well the least altered relics of the ancient Scottish pine woods.

There is much more documentation available now on our old woodlands, so perhaps the main value today of such indices is as a means of assessing the conservation importance of woodland sites. To this end, a more detailed 'New Index of Ecological Continuity' (NIEC) has been devised, containing 70 species instead of merely 30, with the possibility of including other extra rare 'bonus' species, to try to obtain a better conservation value assessment (Table 2). These 'bonus' species are rare (or regionally rare) species worthy of conservation and not necessarily known to be faithful to ancient woodland.

For the studies discussed above, it seemed necessary to try to use a standard-sized area of woodland. An area of $1km^2$ was decided on, as this has some relationship to the mean size of the woodlands or parkland areas studied. Total species lists of lichen epiphytes were also made for all woodlands studied. It is an interesting fact that nearly all those woods with 20 or more RIEC species present have over 100 species of epiphytic lichens per sq. km. The richest sites may have over 200 species per sq. km – all these have extremely high RIEC values.

Some coppiced woodlands, known to be ancient from documentary sources, however, have very low species totals and often no RIEC species at all. An extreme case is Bradfield Woods. This Suffolk woodland has a wonderfully rich vascular-plant flora and contains nearly all the shrubs and trees native to base-rich soils in southern England. However, it contains only small standard trees, and the shrub layer (containing Ash, Hazel, Small-leaved Lime etc.) has been coppiced regularly for centuries. Two independent surveys have been made of its lichen epiphytes. The total number of species seems to be only 15, and there are no RIEC species. At the other extreme lie the major New Forest 'Ancient and Ornamental Woods', which have lichen epiphyte totals per $c.1km^2$ of between 140 and 178, while Melbury Park in Dorset has 218, and Arlington Park in Devon has 213 (see Table 3).

An attempt has been made to produce a similar Index based on bryophyte epiphytes. It has not proved possible because, although there are numerous bryophyte epiphytes, very few of these (mentioned in the discussion of the *Lobarion*) show any correlation with ancient woodland.

Threats to epiphytic communities

The main threats to our epiphytic communities today are acid rain (mostly dilute sulphuric acid from oxidised sulphur dioxide which has travelled for a long distance from pollution sources), and unsuitable forest management.

Direct sulphur-dioxide pollution, so toxic to epiphytes, has become much reduced in recent years, so that some recolonisation by sensitive species, with effective dispersal mechanisms, is occurring even in the suburbs of London and Manchester. But the acidification of bark remains a great threat, and this effect is much graver in central Europe now than in Britain.

Where the air is still clean (as in west Scotland) or cleaner than it was (much of southern England), the main threat is unsympathetic forestry, but conservation bodies are now well aware of this problem and strenuous efforts are being made to improve matters. See Rose (1992) for a fuller discussion of this.

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