Indices of Ecological Continuity for Woodland Epiphytic Lichen Habitats in the British Isles

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A.M. & B.J. Coppins

1. INTRODUCTION

This manual is dedicated to Dr Francis Rose MBE, who first grappled with the evidence and formulated the use of lichens as indicators of ecological continuity in British deciduous woodlands (Rose 1974, 1976, 1992, 1993). Both authors acknowledge a deep debt of gratitude to Francis Rose, and present here for the first time in a single publication the national and regional indices, most of which he pioneered. The updated indices are presented here so as to be readily available for all site surveyors, who can then make comparable, across-the-board site assessments.

Since the inception of the various regional lichen indices, on-going field work has largely confirmed the validity of the lichen species selected as indicators, and they are presented here following Francis Rose's original drafts. Indeed, except for the updating of nomenclature, the main lists of indicator species remain unchanged. However, because of improved knowledge of the distribution and ecology of many lichens, we have revised the suggested examples for 'Bonus' species, but realise that future amendments are inevitable as such knowledge increases further. Two indices, one for broad-leaved woodland in Western Ireland and another for use in Native Pinewoods and old growth Scot's pine plantations, are published for the first time.

Lichen nomenclature follows Coppins (2002), but see also Appendix I.

2. SITE ASSESSMENT AND LICHEN INDICES FOR EPIPHYTIC LICHEN HABITATS OF DECIDUOUS (BROAD-LEAVED) WOODLANDS

To evaluate and compare the lichen and conservation interests of deciduous (broad-leaved) woodland sites in Britain various criteria are applied. The grading of deciduous woodlands, parklands and Native Pinewoods in Britain for their lichen interest started with the report prepared by the Woodland Working Party of the British Lichen Society in 1982 (Fletcher *et al.* 1982). This report was a national survey that listed and graded known woodland and parkland sites in Britain in terms of importance of their lichen floras. Although the data is now twenty years old, it remains a valuable guide, and still forms the basis for grading woodlands today, and entries are periodically updated as new survey work is undertaken. Fletcher *et al.* (1982) classified woodlands into ten broad ecological groups (e.g. lowland parkland, oceanic valley woods, upland oceanic oak and birch, continental-type woods, Native Pinewoods, etc.), so that comparisons between similar sites can be made. The grading system ranks from Grade 1 - international importance, through to Grade 7 - sites of no lichenological importance. Not all of the ten ecological woodland groups included a site of Grade 1 status. Grading is based on various criteria, including the total number of species, the presence of notable species/communities, the potential viability of the populations, as well as the application and scores of appropriate Lichen Indices.

2.1. National Lichen Indices for woodland continuity and quality

RIEC: (**Revised Index of Ecological Continuity**; Rose 1976, 1993, Rose & Coppins 2002) This is used to grade the 'ancient woodland' characteristics of deciduous woodlands throughout the whole of Great Britain and Ireland. **(TABLE 2).** The RIEC is based on reference to documentary sources and extensive field work carried out by Dr Francis Rose, whereby he identified a base list of 30 indicator lichens which appear to be faithful to woods that have retained varying degrees of ecological integrity over time. Most of the species in this list have affinities with the *Lobarion pulmonariae* and the *Lecanactidetum premneae* communities. It is assumed that the 'best' woods will only ever achieve a maximum of 20 out of the 30 indicator species, allowing for differences in woodland structure and the geographical distribution of lichens throughout Britain. The Index is thus expressed as a percentage, with 20 RIEC species giving an RIEC value of 100% (RIEC = $n/20 \times 100$, where n is the number of Indicator Species). In some cases there is flexibility in the method with regard to certain species occurring within a given woodland, e.g. where *Sticta fuliginosa* and *S. sylvatica* both occur within a wood, then only one is counted towards the overall total. See Table 2 for guidance on interpretation of RIEC values.

NIEC: (**New Index of Ecological Continuity**; Rose 1992, 1993, Hodgetts 1992, Woods & Orange 1999, Gilbert 2000) **(TABLE 3).** The NIEC was developed in response to advances in knowledge of the taxonomy, ecology and distribution of epiphytic lichens in the 16 years since publication of the RIEC in 1976. The NIEC is applicable to most of lowland Britain north to Galloway but excluding most of Northumberland and those parts of Powys, Hereford, Worcestershire and Shropshire that fall within the 'rain shadow' of the Welsh mountains. Woodlands of the upland areas of SW England and Wales, Cumbria, Dumfries and Galloway also fall outside the NIEC area. All of Ireland apart from the SW (Kerry and Cork) and western Mayo and Galway, are also appropriate for the NIEC (see Map 1).

The NIEC is based on a list of 70 species primarily devised towards grading woodlands for their conservation status, rather than just focusing on the 'old woodland' interest. As these two interests are usually linked, the NIEC in fact incorporates nearly all of the RIEC species. The NIEC is not intended to replace the RIEC, but to be used in conjunction with it, as the latter indicates the 'ancient woodland' qualities, whilst the former has broader application to assess the overall conservation importance of a given woodland site. Sites with a *T* value of 30 or more are considered to be of high conservation importance, whereas those scoring < 20 are likely to be of limited importance. See Section 2.1.1 for guidelines for 'Bonus' species and *T* values.

2.1.1. The 'Bonus' concept

Additional significant local or rare species not included in the NIEC base list of 70 species, are counted as 'Bonus' species as they add to the overall conservation interest. A list of candidate Bonus species for the NIEC is shown at the end of Table 3, but a few additional species could qualify, for example by reference to the the Red Data Book (Church *et al*. 1996), Conservation Evaluation table (Woods & Coppins in prep.), and/or the British Lichen Society Distribution Maps (Seaward 1995 *et sqq*.). For example, a species whose current rarity status distribution is Nationally Rare (NR) or Nationally Scarce (NS), may in fact be one that is only recently described (e.g. *Micarea coppinsii*) and is likely to be widely distributed and common, and should not be counted as a Bonus. Other NR or NS species may have been under-recorded and should not be included as Bonus species. These include *Gyalecta derivata* and *Opegrapha multipuncta*, which were both listed as 'Bonus species' for the NIEC by Rose (1992: 229). Reference to Woods & Coppins (in prep.) will help to clarify the status of scarce species, by checking to see if they are categorized as Least Concern (LC),

in which case they would not qualify as a Bonus species, unless, perhaps, they occur well outside their normal distributional range (if this is sufficiently well known), or are listed as being an International Responsibility (IR) of Britain.

Hence, the perceived rarity status of species may well change over time, with some formerly considered NR or NS species proving to be more common. The conservation evaluation of individual species will not necessarily remain static either, with some species found to be more common and widely occurring than previously thought, and others increasing their range and population sizes, and vice versa.

We admit that the the Bonus concept can be a confusing and complicating factor when comparing index values, and that the selection of Bonus species, even with guidelines, is still very much at the discretion of the surveyor at a particular point in time. However, we have found that the inclusion of Bonus species is an invaluable supplement when evaluating sites for their conservation importance. In order to compsensate for the subjectivity of selection, **the Bonus species selected for an individual site must always be identified in the species list(s) for the site repor**t, so that they can be re-evaluated at a later date. Bonus species are added to the NIEC total, to give an overall Index figure (total) denoted as "*T*", and **should always be cited** as **No. of Main list species + No. of Bonus species = *T***, e.g. **NIEC + B = *T*.**

The same guidelines apply when Bonus species are added to the scores of the other indices described below (WSIEC, EUOCIEC, ESIEC, WIIEC), and for the NPIEC (see Section 3). For each of these indices, a suggested list of appropriate Bonus species is provided, but these lists are by no means exhaustive. Although the Red Data Book (Church *et al*. 1996) and Conservation Evaluation (Woods & Coppins in prep.) apply only to Britain, we suggest that these are consulted with regard to the use in Ireland of the NIEC and WIIEC, until such time as equivalent Irish evaluations are available.

2.2. Regional Lichen Indices for woodland continuity and quality

Geographical and climatic variation within the British Isles is reflected in the range of lichen communities and species present for a given locality. Hence, in areas where the NIEC is not applicable, regional Indices have been developed by Dr Rose (in conjunction with Dr Brian Coppins) in an attempt to assess the conservation importance of woodlands, where significant lichens and communities which indicate species and habitat diversity within different climatic regions can occur. These regional Indices are for use in western Scotland, wet upland western woodlands, eastern Scotland (including NE England and parts of the English-Welsh borders) and western Ireland, all areas where the NIEC is not applicable (see Map 1). A separate index applicable to woodlands of native Scot's pine is treated in Section 3.

Map 1 provides a rough guide to the applicability of each index. However, the lines on the map do not represent sharply defined delineations, and in border areas it may prove difficult to decide what index to use. In such cases of doubt the surveyor is recommended to use the relevant alternatives, such as:

EUOCIEC/ESIEC/NIEC	England-Wales border
EUOCIEC/NIEC	SW England, W Wales, Lake District, SW Scotland
EUOCIEC/WSIEC	W Scottish Highlands, and areas around Clyde valley
ESIEC/NIEC	England-Wales border, Northern England, Scottish Borders and Southern Uplands
ESIEC/NIEC/WSIEC	western Central Lowlands of Scotland (around the Clyde valley)
ESIEC/WSIEC	Central Scottish Highlands, Central Northern Highlands
NIEC/WIIEC	W Ireland

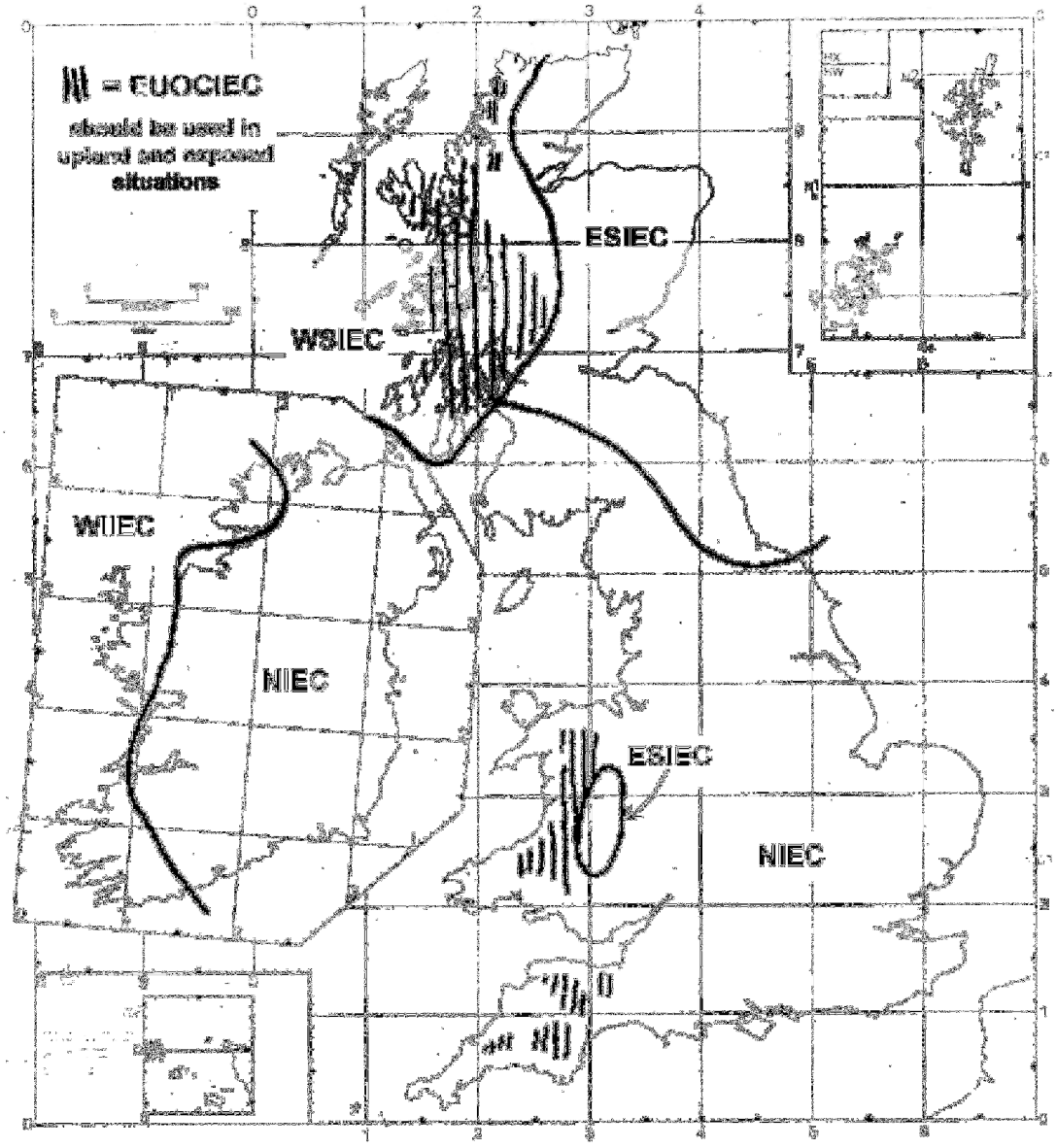
WSIEC: (**Western Scotland Index of Ecological Continuity**; Rose & Coppins unpublished, Hodgetts 1992) **(TABLE 4).** The mild, wet, Atlantic climate experienced along much of

lowland and coastal western Scotland gives rise to particular lichen communities (mostly western facies of the *Lobarion pulmonariae* and the *Graphidion scriptae*; James *et al*. 1977). These assemblages contain not only 'ancient woodland' species, but they are present in an abundance unparalleled elsewhere in Europe, and are therefore of high international importance. The WSIEC has a base list of 50 species. As with the NIEC, the 'Bonus' concept also applies to the WSIEC, with species such as *Graphis alboscripta* (Scottish endemic) counting as a Bonus species to be added to the overall total when present, giving a final (*T*) Index value (see Section 2.1.1 for guidelines for Bonus species). Sites with a *T* value of 25 or more are considered to be of high conservation importance, whereas those scoring <20 are likely to be of limited importance. The WSIEC may also be applicable to SW Norway.

EUOCIEC: (**Eu-Oceanic Calcifuge Woodlands Index of Ecological Continuity**; Rose & Coppins unpublished; Hodgetts 1992) **(TABLE 5).** This Index applies to western woodlands in upland or exposed situations in high rainfall areas with a low or very low potential water deficit and where significant leaching of the bark occurs, producing rather acidic conditions (e.g. upland birch-oak-willow woods). Such woodlands are sometimes contiguous with more sheltered woodland for which the NIEC or WSIEC are more applicable. Lichen communities under these more exposed conditions (primarily the *Parmelion laevigatae*; James *et al*. 1977) can also contain several significant species indicative of habitat diversity and undisturbed conditions. The areas of application for the EUOCIEC fall within those defined as hyperoceanic or euoceanic by Birse (1971). Although the "Eu-oceanic" may not be strictly appropriate for this index, we have chosen to retain it for the sake of continuity! The EUOCIEC has a base list of 30 species, and the 'Bonus' concept can be applied for additional notable species (see Section 2.1.1 for guidelines for Bonus species). Sites with a *T* value of 10 or more are considered to be of high conservation importance.

ESIEC: (**Eastern Scotland Index of Ecological Continuity**; Rose & Coppins unpublished, Hodgetts 1992) **(TABLE 6)**. This Index is applicable mostly to deciduous woodlands in the drier, more continental climate of eastern Scotland, NE England, western Hereford, Worcestershire and Shropshire and eastern Wales. The ESIEC is also applicable to Jutland and southern Sweden. Lichen communities here will include an eastern, continental facies of the *Lobarion pulmonariae* and a significant presence of the *Calicion hyperelli*. The ESIEC has a base list of 30 Indicator species. The presence of six or more *Caliciales* within a given woodland site counts as a score of one. The 'Bonus' concept can be applied (see Section 2.1.1 for guidelines for Bonus species), which, when added to the overall ESIEC, gives a *T* value. Sites with a *T* value of 10 or more are considered to be of high conservation importance.

WIIEC: (**Western Ireland Index of Ecological Continuity**; Rose unpublished) **(TABLE 7)**. Deciduous woodlands occurring in the extremely mild and oceanic climate of western Ireland can support a markedly luxuriant oceanic facies of the *Lobarion pulmonariae* and *Graphidion scriptae*. The base list of 50 Indicator Species contains several lichens that are rare in western Scotland (e.g. *Parmentaria chilensis* and *Pyrenula dermatodes*), as well as species that (in a British Isles context) are known only from SW Ireland (*Haematomma sorediatum* and *Leptogium juressianum*). To some extent, the WIIEC is also applicable to Macaronesia. The 'Bonus' concept can be applied. Guidelines for the selection of Bonus species is given in Section 2.1.1 and although the Red data Book (Church *et al*. 1996) and



Map 1. Showing areas where each Lichen Index for Ecological Continuity for deciduous woodlands is appropriate.

Near boundaries, both indices should be used.

NIEC = New Index of Ecological Continuity

ESIEC = Eastern Scotland Index of Ecological Continuity

WSIEC = Western Scotland Index of Ecological Continuity

WIIEC = Western Ireland Index of Ecological Continuity

EUOCIEC = Eu-Oceanic Calcifuge Woodlands Index of Ecological Continuity

Conservation Evaluation (Woods & Coppins in prep.) apply only to Britain, we suggest that these are used until equivalent documents are available for Ireland. Added Bonus species to the WIIEC give an overall *T* value. Sites with a *T* value of 25 or more are considered to be of high conservation importance, whereas those scoring < 20 are likely to be of limited importance. **NB:** Howard Fox (pers. comm.) comments that the WIIEC list probably contains too high a proportion of very rare species, and that the list may need future adjustment so as to give a better resolution for comparison of site data.

2.3. Local or specialized indices

The indices presented here are recommended for use over large geographical areas. However, supplementary local or specialized indices can be developed to suit particular purposes. For example, Wolseley & O'Dare (1989, 1990) devised their 'NIEC (Exmoor)', based on Rose's draft NIEC, for use in a large survey of woods on Exmoor in SW England. As explained below (Section 2.5) the main indices can be of limited value in areas with present or past high levels of atmospheric pollution. In such areas, it is sometimes possible to find a few species that are locally indicative of woodland continuity, but not recognized as such in 'clean air' regions. A good example is *Graphis scripta* in the English Midlands and in the Lothians. Specialized or 'niche' indices could also be devised: we are currently accumulating data for one to assess the *Graphidion* component of Atlantic hazelwoods, and another suitable candidate is dead wood habitats within deciduous woodlands. Indices of ecological continuity can be developed for other, non-wooded habitats, such as the Maritime Index being revised by Peter James and Pat Wolseley from their original draft (Wolseley & James 1991). Similar indices have also been mooted for stonework in churchyards and for prehistoric megaliths. However, **we must emphasize the need for testing any draft indices over a wide geographical range before they are suggested for general application in site survey reports**.

2.4. Indication of conservation importance

In the above outline of each index, and in Tables 3–7, the statements such as "Sites with a *T* value of 25 or more are considered to be of high conservation importance" require some qualification. These statements must be considered only as a rough guide. Almost without exception, sites above the stated threshold will be of high conservation importance for their lichen interest as well as other features. Sites with lower values are likely to be of less conservation importance, at least for their lichen interest, but certainly there are exceptions. For example, a site with a rather low *T* value may have an exceptionally well-developed and viable population of a rare, 'Priority' species, much better than in other woodlands with higher *T* values, where the species is present in small, isolated and possibly endangered populations. An example is Urquhart Bay Wood (WSIEC *T* = 10), which supports a large population of the Red-listed *Fuscopannaria ignobilis*. **Thus, although the Index values provide a valuable aid to the assessment of a site, they should never be taken as the sole basis for such an assessment**.

2.5. Limitations to the application of epiphytic lichen indices

In areas currently or previously affected by high levels of atmospheric pollution or acid rain, there will have been a severe effect on most lichen taxa, so application of the RIEC in affected areas will not result in an accurate picture as to whether a woodland is of ancient origin and has retained, in respect of woodland structure, ecological continuity over time. Hence, the impoverished lichen floras (and low RIEC values) of many known ancient

parklands in central lowland England do not reflect their antiquity. Woodlands adjacent to other sources of pollution (such as brickworks, aluminium smelters or limestone quarries) will also have lower RIEC values than would otherwise be expected, owing to these localized environmental influences. The growing concern over modern agricultural pollution, particularly in areas of intensive livestock farming, is that the high levels of ammonia are causing changes to epiphytic lichen floras at woodland edges, resulting in losses of some 'ancient woodland' species, depauperization of relic communities, and replacement at best by the *Xanthorion parietinae* community, and at worst by ubiquitous algae such as *Desmococcus* sp.

It is a similar story for the NIEC, which includes most of the RIEC species but has a broader remit to include species of conservation importance other than 'ancient woodland' indicators. Lichen assemblages reduced or changed through various forms of pollution will include few if any NIEC species. Neither the RIEC nor the NIEC include any species from the *Xanthorion parietinae* community.

Pollution is not such a problem for the WSIEC, ESIEC or the WIIEC, as the areas where these Indices are applicable are largely in clean air zones. However, the Cowal Peninsular and nearby parts of the Kintyre Peninsular in western Scotland lie west of the Glasgow conurbation, and significant atmospheric pollution and acidification effects have been noted in the low altitude epiphytic lichen floras here, which has led to lower WSIEC values than would be anticipated from the mild, wet climate (O'Dare & Coppins 1992). Indeed, the resultant floristic composition of the epiphytic flora means that the EUOCIEC is often more relevant here, even in sheltered lowland situations. Long-distance atmospheric pollution (usually experienced as 'acid rain'), can also have detrimental effects on the lichen floras of trees in upland and exposed woodlands, leading even to a reduced value of the EUOCIEC. Similar 'long-range' effects have been noted, elsewhere, such as in the Cheviot Hills of Northumberland (Gilbert 1986), leading to lower than expected ESIEC scores.

A far more wide-ranging limitation that affects all epiphytic lichen Indices is that of woodland management. In this respect, coppiced woods (where trees are cut back on a regular cycle, such as oak (*Quercus* spp.) for charcoal and tanning, but especially hazel (*Corylus avellana*), for a variety of small-wood uses), will have very poor Index values. This, despite the fact that many coppiced woods are of known ancient origin. Coppicing effectively removes all epiphytic lichens with the cut wood, in the same way that clear-felling a woodland of timber trees will. In coppiced woodlands where mature standard trees are also present, the lichens on such trees are subject to drastic changes of light and humidity during the regular coppice cycles, so generally will support poorly developed and species-poor lichen communities, with few (or no) ancient woodland Indicator Species of the RIEC, despite the fact that these trees may be of great age. This is not to suggest that all hazel woodlands are of low conservation interest; there is no evidence that many stands of pure hazel in parts of lowland western Scotland and Ireland were ever extensively coppiced, but rather were selectively cut, preserving ecological continuity within the stand. Hence, some of the highest WSIEC and WIIEC values occur in hazel woodlands (Coppins & Coppins 2000, Coppins *et al*. 2002).

The common purpose of all of the lichen Indices is that they indicate **ecological continuity** within a woodland, the theory being that the more critical species (the ones of conservation importance) are poor colonizers and require regular availability of suitable habitat niches within the woodland ecosystem. Once the woodland has undergone quite severe habitat disturbance (such as clear-felling or regular coppicing), the niche presence is disrupted. So, in some cases, apparently suitable old-growth woods may have low lichen Index values; this indicates that at some period in the past, these woods were cleared and may have been re-planted or even regenerated naturally, but the all important ecological continuity has been broken, resulting in a loss of lichen diversity. Although past management may have had limitations on the end results of applying lichen Indices (i.e. low value scores), in some

respects the use of these Indices can show much about the past history of a particular woodland site.

2.6. Saxicolous or terricolous habitats within woodlands

There are no equivalent indices for comparing or assessing the conservation importance of lichens or lichen assemblages occurring on rocks or soil within woodland. Rock outcrops, boulders, scree, earth banks and open heathy glades can significantly contribute to the lichen interest and diversity of a woodland site, and where notable saxicolous and terricolous species are recorded, their significance should be mentioned in the text of any accompanying report, with reference to the Conservation Evaluation table (Woods & Coppins in prep.) and BLS Distribution Maps. Outside of woodlands, lowland heath, dune, machair and shingle lichen habitats are partially covered in a report made by the British Lichen Society Heathland Working Party (Fletcher *et al.* 1984). This report is the single current basis for making site assessments of these habitats, but it was prepared nearly twenty years ago, and since that time enormous strides have taken place in our understanding of the lichen biodiversity and ecology of terricolous habitats. The report acknowledges singular inadequacies in its undertaking, and for more up-dated analysis of the lichen floras of a limited selection of these habitats see "Grey Literature" on the BLS web site.

2.7. General Methodology

Individual woodland sites are surveyed by expert lichenologists. The method involves making detailed species lists, usually annotated to individual tree species encountered on entering the site. This forms the basis for beginning to understand the site and what it has to offer. As the survey progresses, only the more 'promising' or unusual trees, shrubs or niches are recorded in detail. In this way, a knowledge of the background flora is established, at the same time as more critical species and communities are identified. Such species tend to be recorded more assiduously, so a picture of populations present and distribution within the site is built up. It has been reckoned that a 'good' tree may take up to 45 minutes to record, taking into account the range of niches found on the trunk, plus any accessible branches and twigs. Additional habitats such as stumps, fallen trunks, decorticate branches, earth banks and rock outcrops add to the overall site diversity, and are an integral part of any woodland site. Problematic species are collected and packeted, carefully labelling the packet for correct insertion of the later determination into the final report. For a species-rich site, it is reckoned on one day's field work taking four day's desk work (including working on problematic species - microscope, TLC, curation - collating data into an annotated species list - including substratum, whether of Red Data Book or other 'Priority' status, Nationally rare/Nationally scarce, whether an RIEC or other Index species, and a DAFOR scale of abundance - report writing, map preparation, comparison with other sites, annotating and preparing any photographs and illustrations - site assessment and site grading). This last makes use of the application of appropriate lichen Indices. It is useful to make tables of sites in similar geographical locations, ranked by appropriate lichen Indices, as in **Table 1**.

2.8. Data collection and analysis

The British Lichen Society web site (http://www.thebls.org.uk/) lists unpublished lichen surveys and other so-called "Grey Literature". For surveys of woodlands, the individual entries mostly include a brief site description, the total number of lichen taxa recorded, and (if a woodland site) the RIEC and any other applicable Indices. The surveys listed cover the whole of the British Isles (although little data from Eire has been forthcoming). This forms the first step towards a valuable collection of lichen survey data, which at a later date can be

taken forward and incorporated into a database. This will facilitate an updated review of the distribution of epiphytic lichen sites in the British Isles and enable analysis of the various woodland sites based on the application of the appropriate epiphytic lichen Indices, thus assisting in a future updating and re-evaluation of the 1982 report on *Survey & Assessment of Epiphytic Lichen Habitats* (Fletcher *et al.* 1982).

TABLE 1

Comparison of some Western Scottish woods ranked by RIEC, EUOCIEC and WSIEC

In this example, the woods listed are only those for which detailed lichen surveys have been carried out within the last 10 years.

Column 1: Total No. of lichen taxa recorded for site.
Column 2: Total No. of epiphytes (on bark &/or lignum).
Column 3: RIEC (Revised Index of Ecological Continuity), the "old woodland" index.
Column 4: EU-IEC (EUOCIEC) (Eu-oceanic Calcifuge Index of Ecological Continuity) species indicating quality and conservation importance for upland woodlands in areas exposed to high rainfall.
Column 5: WSIEC (Western Scotland Index of Ecological Continuity), species indicating quality and conservation importance for lowland woodlands on oceanic Western Scotland.
Column 6: Bonus species very rare or local, to be added to the WSIEC & EUOCIEC.
Column 7: Total (WSIEC + Bonus).

Site	1	2	RIEC	EU-IEC	WSIEC	Bonus	Total
Glen Shira, Argyll	467	298	130	23	40	11	51
Drimnin, etc., Argyll	303	220	120	–	36	9	45
Taynish NNR, Argyll	402	214	125	20	36	5	41
Resipole Ravine SSSI, Westerness	266	188	120	18	35	4	39
Ardura SSSI, Mull	309	213	105	22	29	9	38
Rassal NNR & SSSI, West Ross	365	235	95	19	27	11	38
Fairy Isles, Argyll	294	145	105	–	25	10	35
Ballachuan, Argyll	281	197	110	11	27	6	33
Barnluasgan, Argyll	212	169	100	18	27	4	31
Inverpolly NNR, Wester Ross	273	188	100	17	25	5	30
Coille Mhor, Argyll	176	138	80	15	23	1	24
Inverneil Burn SSSI, Argyll	221	143	100	16	18	1	19
Baleachdrach, Islay	390	183	90	11	16	0	16
Abriachan Wood S, Easterness	222	150	65	–	12	4	16
Torridon, West Ross	329	167	80	17	10	4	14
Mealdarroch NNR, Argyll	229	124	75	13	11	3	14
Uig Woods, Skye	142	132	70	–	13	0	13
Loch a'Mhoulinn, W Sutherland	260	130	75	9	12	2	12
Balnabraid SSSI, Argyll	378	159	80	14	12	0	12
Urqhuart Bay, Easterness	130	130	40	–	9	1	10

[Note that most woodlands in this Table have both WSIEC and EUOCIEC values as there is often an upland element to western Scottish woodlands so that both indices apply].

2.9. Results

In Britain, government and non-government conservation agencies require data on the conservation importance of cSACs, National Nature Reserves and Sites of Special Scientific Interest. Lichen surveys are commissioned and the results written up in a site report, which will include (at least) total number of lichen taxa and the values of appropriate lichen Indices. This enables sites of international, national and regional importance to be recognized, and appropriate action to adequately manage and protect the lichen interest to be taken. Details of individual site reports are added to the "Grey Literature" on the BLS web-site.

2.10. Application of the method

On a broader perspective, can lichen indices be used elsewhere in the world? The British Isles is a comparatively small area and the lichen flora has been studied fairly intensively. We are fortunate to have the benefit of the careful and thorough work that Dr Rose has contributed towards devising a series of lichen Indices which enable conclusions to be drawn in interpreting lichen data recorded from individual woods. The recognition of lichen indicators of 'ancient' or old growth woodland has been revealed by many authors (e.g. Glenn *et al*. 1998, Goward 1994, Gustafsson *et al*. 1992, Nitares 2000, Selva 1994, 1996, Tibell 1992). Rose (1992) discusses the application of using ancient woodland Indices elsewhere in the world, and cites the then unpublished work (see Selva 1996) being carried out in North America. He also mentions pioneering attempts made by Wolseley (1991) to demonstrate communities characteristic of old montane forests in south-east Asia, and the fact that Kantvilas (1985, 1998) had recognized that some lichen species and communities appear to be confined to primeval rainforests in Tasmania. However, at that time (1992), lichen indices had not been refined sufficiently to be truly applicable to southern hemisphere forests.

2.11. Data quality control

Data quality control is largely dependent on the expertise, integrity and efficiency of the individual lichenologist carrying out site recording. By strict adherence to the guidelines set out in Woods & Coppins (in prep.), and reference to the BLS Distribution Maps (Seaward 1995 *et sqq.*), the current evaluation of the lichen interest of a site should conform to something approaching a national standard. In some cases, critical material may need to be sent for determination to specialist referees, and such specimens are then lodged in national herbaria (BEL, BM, DBN, E, NMW) for future reference. Re-visiting sites several years after original site-recording is often very revealing, as it enables some insight into not only the dynamics of individual lichen species, but also of lichen communities and woodland habitats. Depending on the detail recorded in individual site reports, future site visits may throw much light on what are often assumptions about the way individual lichens develop and respond to changes in their environment.

TABLE 2

RIEC - Revised Index of Ecological Continuity

Anisomeridium ranunculosporum
Arthonia vinosa
Biatora sphaeroides
Catinaria atropurpurea
Cresponea premnea
Degelia atlantica/or plumbea/or Parmeliella triptophylla
Dimerella lutea
Enterographa crassa
Lecanographa lyncea
Lobaria amplissima
L. pulmonaria
L. scrobiculata
L. virens
Loxospora elatina
Nephroma laevigatum
Pachyphiale carneola
Pannaria conoplea
Parmotrema crinitum
Peltigera collina
P. horizontalis
Porina leptalea
Punctelia reddenda
Pyrenula chlorospila/or macrospora
Rinodina isidioides
Schismatomma quercicola/or Pertusaria pupillaris
Stenocybe septata
Sticta limbata
S. fuliginosa/or sylvatica
Thelopsis rubella
Thelotrema lepadinum

Maximum total - 30

RIEC is calculated by the number of species n/20 × 100;
e.g. 6 RIEC species gives an **RIEC of 30.**

The **Bonus** concept does not apply to the RIEC.

Interpretation of RIEC values:
Assuming that atmospheric pollution has not been an overriding factor, the RIEC values can generally be interpreted thus:

0–25 = no indication of ecological continuity; the woodland is either a plantation or has been clear felled and regenerated, or coppiced.
30–45 = evidence of some degree of ecological continuity.
50–70 = strong evidence of ecological continuity.
75–100+ = clear evidence of an ancient woodland with a long history of ecological continuity; the woodland has never been clear-felled or extensively coppiced, although trees may have been felled on a selective basis.

Interpretations may need to vary in different areas. For example, New Forest hardwood plantations (planted *c*. 1800) may score as high as 50 where they are surrounded by woodland of much longer ecological continuity (Rose 1976: 294). Secondly, in the highly favourable climate of the western Highlands of Scotland, planted policy woodlands can attain values as high as 60.

TABLE 3

NIEC - New Index of Ecological Continuity

Main species

Agonimia allobata
A. octospora
Anisomeridium ranunculosporum
Arthonia astroidestera
A. ilicina
A. vinosa
Bacidia biatorina
Biatora epixanthoides
B. sphaeroides
Buellia erubescens
Catinaria atropurpurea
Cetrelia olivetorum *s. lat.*
Chaenotheca sp. (excl. C. ferruginea)*
Cladonia caespiticia
C. parasitica
Collema furfuraceum/or subflaccidum*
Cresponea premnea
Degelia atlantica/or plumbea*
Dimerella lutea
Enterographa sorediata
Heterodermia japonica
Lecanactis subabietina
Lecanographa amylacea
L. lyncea
Lecanora jamesii
L. quercicola
L. sublivescens
Leptogium cyanescens
L. lichenoides
L. teretiusculum
Lobaria amplissima
L. pulmonaria
L. scrobiculata
L. virens
Loxospora elatina
Megalospora tuberculosa
Micarea alabastrites/or cinerea*
M. pycnidiophora
Mycoporum antecellens
Nephroma laevigatum
N. parile
Ochrolechia inversa
Opegrapha corticola
O. prosodea
Pachyphiale carneola
Pannaria conoplea/or rubiginosa*
Parmeliella parvula
P. triptophylla
Parmotrema crinitum
Peltigera collina
P. horizontalis
Pertusaria multipuncta
P. velata
Phaeographis sp. (excl. P. smithii)*
Phyllopsora rosei
Porina coralloidea
P. hibernica
Punctelia reddenda
Rinodina isidioides
Schismatomma niveum
S. quercicola/ or Pertusaria pupillaris*
Stenocybe septata
Sticta fuliginosa/ or sylvatica*
S. limbata
Strangospora ochrophora
Thelopsis rubella
Thelotrema lepadinum
Usnea ceratina
U. florida
Wadeana dendrographa

The maximum total above is 70, but the following rare species are among those that can be considered as **Bonus species**: (see Section 2.1.1 for guidelines for Bonus species):

Anaptychia ciliaris
Arthonia anombrophila
A. anglica
A. arthonioides
A. zwackhii
Bacidia circumspecta
B. subincompta
Buellia hyperbolica
Bunodophoron melanocarpum (S England only)
Catillaria alba
Caloplaca herbidella
C. lucifuga
Collema fragrans
C. nigrescens
C. subnigrescens
Cryptolechia carneolutea
Fuscopannaria mediterranea
F. sampaiana
Hypotrachyna endochlora
H. sinuosa
H. taylorensis
Leptogium burgessii
L. cochleatum
Megalaria grossa (S England only)
M. laureri
Menegazzia terebrata
Mycoporum lacteum
Opegrapha fumosa
Parmelinopsis horrescens
P. minarum
Parmeliella testacea
Parmotrema arnoldii
Porina rosei
Pseudocyphellaria crocata
P. intricata
P. norvegica
Pyrenula nitida *s.str.*
Ramonia sp.* (excl. R. interjecta)
Rinodina colobinoides
Schismatomma graphidioides
Sphaerophorus globosus (S England only)
Sticta canariensis/or dufourii*
Teloschistes flavicans
Usnea articulata

*Note that only one species is counted when alternatives or "sp." are given.

Sites with a *T* value of 30 or more are considered to be of high conservation importance, whereas those scoring < 20 are likely to be of limited importance. (See Section 2.4).

TABLE 4

WSIEC - West of Scotland Index of Ecological Continuity

Main species

Arthonia anombrophila
A. ilicinella
A. leucopellaea
A. stellaris
A. vinosa
{Arthonia ilicina } count
{Arthothelium lirellans } one
{A. orbilliferum } only
Bacidia biatorina
Bactrospora homalotropa
Biatora epixanthoides
B. sphaeroides
Buellia erubescens
Calicium lenticulare
Cetrelia olivetorum *s. lat.*
Collema fasciculare
C. nigrescens/ or subnigrescens*
C. subflaccidum
Enterographa crassa
Fuscopannaria sampaiana
Gomphillus calycioides
Graphina ruiziana
Heterodermia japonica
Hypotrachyna endochlora
H. taylorensis
Leptogium brebissonii
L. burgessii
L. cochleatum
L. hibernicum
Lobaria amplissima
L. scrobiculata
Lopadium disciforme
Megalospora tuberculosa
Micarea stipitata
Nephroma parile
Pachyphiale carneola
Parmeliella testacea
Parmotrema reticulatum
Peltigera collina
Phyllopsora rosei
Pseudocyphellaria crocata
P. intricata/ or norvegica*
Punctelia reddenda
Pyrenula laevigata
P. occidentalis
Rinodina roboris
Schismatomma quercicola
Sticta canariensis/ or dufourii*
Strangospora ochrophora
Thelopsis rubella
Thelotrema macrosporum
Thelotrema petractoides

*Note that only one species is counted when alternatives or "sp." are given.

The maximum total above is 50, but the following rare species should be regarded as **Bonus species** where they occur (see Section 2.1.1 for guidelines for Bonus species):

Arthothelium macounii
Biatora chrysantha
B. vernalis
Graphis alboscripta
Cresponea premnea
Lecanactis subabietina
Leptogium saturninum
Mycoporum lacteum
Opegrapha fumosa
Parmentaria chilensis
Parmotrema arnoldii
Polychidium dendriscum
Porina coralloidea
P. hibernica
P. rosei
Pyrenula dermatodes
P. aff. microtheca
Rinodina isidioides
Schismatomma niveum
Stenocybe bryophila
Wadeana dendrographa

Sites with a *T* value of 25 or more are considered to be of high conservation importance, whereas those scoring < 20 are likely to be of limited importance. (See Section 2.4).

TABLE 5

EUOCIEC - Eu-Oceanic Calcifuge Index of Ecological Continuity

Main species

Bryoria bicolor
B. fuscescens
Buellia griseovirens
Bunodophoron melanocarpum
Calicium lenticulare
Cetrelia olivetorum *s. lat.*
Cladonia luteoalba
Graphina ruiziana
Heterodermia japonica
Japewiella tavaresiana
Hypotrachyna endochlora
H. laevigata
H. sinuosa
H. taylorensis
Lecidea doliiformis
Leproloma membranaceum
Loxospora elatina
Megalaria pulverea
Menegazzia terebrata
Micarea alabastrites
M. stipitata
Mycoblastus caesius
M. sanguinarius
Ochrolechia inversa
O. tartarea
Parmelinopsis horrescens
Pertusaria ophthalmiza
Sphaerophorus globosus
Trapelia corticola
Usnea filipendula

The maximum total above is 30, but the following rare species are among those that can be added as **Bonus species**: (see Section 2.1.1 for guidelines for Bonus species):

Arthothelium dictyosporum, *Ochrolechia szatalaensis*, *Platismatia norvegica*, and any additional, main or Bonus species listed for the NIEC or WSIEC.

Sites with *T* values of 10 or more are considered to be of high conservation importance. (See Section 2.4).

TABLE 6

ESIEC - East of Scotland Index of Ecological Continuity

Main species

Arthonia cinnabarina/or elegans*
A. vinosa
Bacidia beckhausii
B. subincompta
Biatora chrysantha
B. epixanthoides
B. sphaeroides
Caliciales - 6 or more species of (Calicium, Chaenotheca, Chaenothecopsis, Cyphelium, Microcalicium, Mycocalicium, Stenocybe or Sclerophora) *
Catillaria globulosa
Catinaria atropurpurea
Cladonia parasitica
Degelia plumbea
Flavoparmelia caperata
Fuscopannaria mediterranea
Lobaria pulmonaria
L. amplissima/or scrobiculata/ or virens*
Lopadium disciforme
Loxospora elatina
Megalaria grossa
M. pulverea
Nephroma laevigatum/or parile*
Normandina pulchella
Pachyphiale carneola/or fagicola*
Pannaria conoplea
Parmeliella triptophylla
Peltigera collina
Pertusaria hemisphaerica
Sticta limbata
S. fuliginosa/ or sylvatica*
Thelotrema lepadinum

The Maximum total above is 30, but the following rare species are among those that can be considered as **Bonus species**: (see Section 2.1.1 for guidelines for Bonus species):

Agonimia allobata
Arthonia zwackhii
Bacidia circumspecta
B. igniarii
B. vermifera
Biatoridium sp.*
Catapyrenium psoromoides
Catillaria alba
Catinaria neuschildii
Collema fasciculare
C. furfuraceum/or C. subflaccidum*
C. nigrescens
Enterographa crassa
Fuscopannaria ignobilis
Gyalecta flotowii
G. ulmi
Lecanographa amylacea
Leptogium saturninum
Pertusaria multipuncta
Ramonia sp.* (excl. R. interjecta)
Rinodina flavosoralifera
Schismatomma graphidioides

*Note that only one species is counted when alternatives or "sp." are given.

Sites with *T* values of 10 or more are considered to be of high conservation importance. (See Section 2.4).

TABLE 7

WIIEC - West Ireland Index of Ecological Continuity

Main species

Arthonia astroidestera
A. ilicina
Arthothelium lirellans/or orbilliferum*
Bacidia biatorina
Bactrospora homalotropa
Biatora epixanthoides
Blarneya hibernica
Collema fasciculare
C. nigrescens/ or subnigrescens*
Dimerella lutea
Fuscopannaria sampaiana
Graphina ruiziana
Haematomma sorediatum
Heterodermia japonica
Hypotrachyna endochlora
H. laevigata
H. taylorensis
Japewiella tavaresiana
Lecanora jamesii
Leptogium brebissonii
L. burgessii
L. cochleatum
L. hibernicum
L. juressianum
L. lichenoides
Lobaria amplissima
L. pulmonaria
L. scrobiculata
L. virens
Loxospora elatina
Megalaria grossa
Mycoporum lacteum
Nephroma laevigatum
N. parile
Ochrolechia inversa
O. szatalaensis
Pachyphiale carneola
Parmentaria chilensis
Pertusaria velata
Phaeographis lyellii
Porina atlantica
P. hibernica
Pyrenula dermatodes
Rinodina isidioides
Stenocybe bryophila
Sticta canariensis
S. dufourii
Thelotrema macrosporum
T. petractoides
Trapelia corticola

*Note that only one species is counted when alternatives or "sp." are given.

The maximum total above is 50, but the following rare species are among those that can be considered as **Bonus species**: (see Section 2.1.1 for guidelines for Bonus species):

Calicium diploellum, *Leptogium coralloideum*, *Parmotrema robustum*, *Phyllopsora rosei*, *Pseudocyphellaria* spp.

Sites with a *T* value of 25 or more are considered to be of high conservation importance, whereas those scoring < 20 are likely to be of limited importance. (See Section 2.4).

3. SITE ASSESSMENT OF NATIVE PINEWOODS USING EPIPHYTIC LICHENS

3.1. Background - indicator species of long-term continuity of pinewoods

Epiphytic lichens have long been regarded as bio-indicators of ancient woodlands (Rose 1976, 1992). 'Ancient' woods are taken to mean sites that have been continuously wooded since 1600 (Peterken 1996). The reason for the reliability of epiphytic lichens in this role is simply that if a woodland has been clear-felled at any time during its history, then all the associated lichens would go with the extraction of the felled trees. Unlike a woodland ground flora, which can survive a clear felling if the woodland is quickly regenerated or planted, certain assemblages of epiphytic lichen are dependent on continuity of woodland cover, and some are exclusively dependent on the continual presence of old trees (Rose 1976, 1993, Sanderson in prep.). In native pinewoods, this habitat dependency also extends to the continual presence of dead trees.

Pitkin *et al.* (1995) state that there is no single vascular plant or bryophyte that can be regarded as an invariable indicator of long-term antiquity or continuity in the original native pinewoods of Scotland, as the characteristic species most closely associated with this habitat (e.g. *Goodyera repens*, *Linnaea borealis*, *Moneses uniflora*), also occur in Scots pine woods known to be of planted origin. However, it was suggested that if several of the characteristic vascular plants were found to occur in one site, together with the moss *Ptilium crista-castrensis* or the liverwort *Anastrophyllum hellerianum*, this would suggest a site with high potential of being of considerable age. They considered fungi and lichens may be better indicators of ancient status in native Scottish pinewoods than vascular plants, and singled out the work by Orton (1986) on fungi as an example.

3.2. Lichens as indicators of long-term continuity of pinewoods

Studies on the distribution of the native pinewood lichen flora have not been as exhaustive or as extensive as those made for fungi by Orton (1986). For example, no systematic recording of the lichen floras found in planted Scots pine woods or non-native planted conifer woods throughout Britain has been undertaken. Although several Scottish pinewoods of planted origin have been recorded in detail for their lichen flora (e.g. Culbin Forest and Braco pinewood), data from many of the northern and southern coniferous woodlands has largely been gathered in an *ad hoc* basis.

Over the last 25 years, Brian Coppins has gathered data relating to the native pinewoods of Scotland, and (excluding the numerous additional species confined to rocks), 432 epiphytic lichen taxa have so far been recorded. Of these lichens, about 220 have been recorded from the bark, lignum or stumps of pine itself. Seventeen species are, in the British Isles, confined to native pinewoods **(Table 8)**. Some of the lichens in this list are known only from the Eastern or Central Scottish native pinewoods, whereas others have more western distributions.

An additional *c*. 60 species are generally considered to be indicative of ancient woodland but occur also on the bark or lignum of broad-leaved trees in both native pinewoods and deciduous woodlands. (Native pinewoods are considered in the context as containing not only Scots pine, but also the deciduous/broad-leaved element of the habitat, e.g. birch, rowan, holly, etc.). From this pool of 77 or so species **(Table 9)**, a 'Native Pinewood Index of Ecological Continuity' has been devised, to be used in a similar way to the 'New Index of Ecological Continuity' (NIEC) for lowland, deciduous woodlands.

Table 8

Lichen species confined to Scottish native pinewoods in the British Isles

Sub. = substratum; B = on birch; Cl = on heather; J = on juniper; P = on pine; PL = on pine lignum; Pp = aspen; Sb = on rowan

	Sub.		Sub.
Bryoria furcellata	B,Cl,P,PL	L. porphyrospoda	PL
Buellia sanguinolenta	Sb	Lecidella subviridis	J
Chaenothecopsis pusiola	PL	Melaspilea lentiginosula	P
Cladonia cenotea	PL	Micarea contexta	PL
Hypocenomyce anthracophila	PL	M. elachista	PL
H. leucococca	P	M. eximia	PL
Lecanora cadubriae	P,PL	Pycnora xanthococca	PL
L. mughicola	PL	Rinodina laevigata	Pp
Lecidea leprarioides	P		

Table 9

Main species used in the Native Pinewood Index of Ecological Continuity (NPIEC)

Alectoria sarmentosa
Arthonia leucopellaea (NS)
[D]A. vinosa
Bryoria capillaris (NS)
B. furcellata (RDB VU)
Calicium parvum (NR)
Cavernularia hultenii (NS)
Chaenotheca brunneola/ or trichialis*
C. chrysocephala
C. xyloxena (RDB VU)
Chaenothecopsis pusiola (NR)
Chrysothrix chrysophthalma (NR)
Cladonia botrytes (RDB CR, BAP)
C. cenotea (NR)
Cyphelium inquinans
C. tigillare (NR)
[D]Degelia atlantica/ or [D]plumbea*
Elixia flexella (NR)
Hypocenomyce friesii (NS)
Hypotrachyna laevigata
Imshaugia aleurites
Lecanora cadubriae (NS)
Lecidea botryosa (NR)
L. hypopta (NS)
L. turgidula
[D]Lobaria sp.*
Lopadium disciforme
Loxospora elatina
Megalaria pulverea
Melaspilea lentiginosula (NR)
Micarea adnata (NS)
M. alabastrites
M. contexta (NR)
M. hedlundii (NR)
M. stipitata (NS)
M. synotheoides (NS)
Microcalicium ahlneri (NS)
M. disseminatum (NR)
Mycoblastus affinis (NS)
M. alpinus (NR)
[D]Pannaria (including Fuscopannaria) sp.*
Pertusaria borealis (NS)
P. ophthalmiza (NS)
Platismatia norvegica (NS)
Protoparmelia ochrococca (NS)
Pycnora xanthococca (RDB VU)
[D]Sclerophora pallida (RDB VU)/ or [D]peronella (NS)*
[D]Sticta sp.*
[D]Thelotrema lepadinum
Xylographa parallela/or trunciseda (NS)/or vitiligo*

[D]species not found on pine bark or lignum, but on associated broad-leaved trees within the pinewood habitat.

RDB = Red Data Book (Church *et al.* 1996; Woods & Coppins 2002)
RDB CR = Critically Endangered; RDB EN = Endangered; RDB VU = Vulnerable; RDB DD = Data Deficient; BAP = Biodiversity Action Plan species
NR = Nationally rare (recorded in less than 16 10 km squares in the British Isles)
NS = Nationally scarce (recorded in 16–100 10 km squares in the British Isles)

*Note that only one species is counted when alternatives or "sp." are given.

3.3. NPIEC: (Native Pinewood Index of Ecological Continuity)

3.3.1. Climatic variability

There is a considerable variation, mainly connected with oceanicity, among the Scottish pinewoods. The lichen floras of the western forests (such as Barrisdale and Coulin), have a markedly different composition to those of Deeside and Speyside in the east, which experience a lower rainfall and greater temperature fluctuation throughout the year. The forests of the Central Highlands (e.g. Affric, Guisachan and Strathfarrar) fall somewhere in between, and generally have the richest and most varied floras. In order to allow for this great variation, the Index is divided into three parts. The first part ('Widespread') involves taxa with a widespread distribution, applicable to all pinewoods, and has a maximum score of 20. The second part is mainly applicable to the Western group, and the third to the Eastern group**;** both these latter parts giving a maximum score of 15, and both are also applicable to the Central group. Hence, although the Index maximum is 50, by combining the 'Widespread' category with the regional categories, scores above 35 are unlikely, except for the richest woodlands of the Central group **(Table 11)**.

The Index offers further flexibility in that the woodlands of the Western group can be compared amongst themselves, and likewise the Central and Eastern groups.

3.3.2. Application and interpretation of NPIEC

What do the total NPIEC scores shown in Table 11 for the individual pinewoods tell us about these woods? From studies of 'old-growth' native pinewoods in Scotland and elsewhere in boreal regions of the world, it is recognized that mature habitats within these woods (or forests) are species-rich where there has been long ecological continuity. Degrees of disturbance will disrupt or fragment the habitat and natural processes, and species diversity may be reduced, through permanent or even temporary loss of particular habitat niches.

Hence, having established a list of lichens that appear to require niches associated with long-term ecological continuity from known 'ancient' pinewoods, the presence or absence of species from this list can be used to gauge to what degree individual pinewoods have retained ecological integrity.

As has already been discussed, climate, and particularly oceanicity, need to be taken into account when making comparison between individual pinewoods, and the NPIEC is designed to do this. Other factors which cannot be included in the equation are (i) size or extent of the area of pinewood, (ii) the amount of survey time that has been expended on each wood, and (iii) the distribution and population sizes within each wood of the indicator species used to calculate the NPIEC.

The NPIEC is a 'broad brush' rather than a 'precise instrument', but it does provide a simple and accessible key to distinguish the conservation importance in terms of lichen interest, between Scottish native pinewoods. It is intended that this index will be used to compare pinewoods of known ancient origin and extensive continuity with woods of uncertain history.

In connection with this, the NPIEC can also be usefully extrapolated to gauge the degree, or period of time taken for mature pinewoods, of known planted origin, to acquire the necessary habitat niches that will support specialized lichens. How many generations of pine does it take before a 'mature' and niche-rich habitat with associated specialist lichen communities is achieved within a stand? Is close proximity to existing lichen populations in nearby native pinewoods a necessary requirement?
In terms of future management of our native pinewoods, this would give a valuable estimate as to how quickly specialist pinewood lichens can invade created habitats. This is pertinent,

for example, to the recent extensive planting that has been carried out within Beinn Eighe NNR on the slopes around ravines where relic pinewood fragments persist. It also has particular significance for older pine plantations on the lower edges of Coille na Glas Leitire at Beinn Eighe (Coppins & Coppins 2001). The present situation here with regard to the individual NPIEC scores for the three plantations surveyed, clearly demonstrates that the presence of older trees pre-dating the plantations are crucial to the lichen interest, and that broad-leaved trees within western native pinewoods will begin to acquire communities with the more demanding species at an earlier time than pine trees.

Woodlands of secondary origin (but not in close proximity to native pinewoods) that have so far been compared using the NPIEC include Braco pinewood (scoring 5 out of 50), Culbin Forest (scoring 4) (both of these have received at least 2 days' fieldwork), and Tomnaghuail Wood at Cawdor (scoring 9), with 1 day's fieldwork.

3.3.3. 'Bonus' species

Species which are very rare, either nationally or locally, are considered 'Bonus' species as they add to the overall conservation importance of a particular site, e.g. on pine lignum, *Hypocenomyce anthracophila* (RDB listed Endangered) **(Table 10)**. As the pinewood habitat encompasses deciduous trees, then similarly, rare species found on these would also count as 'Bonus' species, e.g. on aspen, birch, juniper or elm, *Bacidia vermifera* (RDB listed Endangered). (See Section 2.1.1 for additional guidelines regarding Bonus species).

Alternatively, the occurrence of a species outside its normal range would also be considered a 'Bonus', such as *Lobarion* community species occurring on deciduous trees in Eastern native pinewoods. This 'bonus' category is not included in Table 11, but nomination of a species as deserving of 'bonus' status is at the discretion (and experience) of the surveyor, and with reference to the Conservation Evaluation Table (Woods & Coppins in prep.) and the British Lichen Society Distribution Maps.

Table 10

Some lichens considered as 'Bonus' species in native pinewoods

(i) on pine and/or pine lignum

Arthonia arthonioides (NS)
Buellia arborea (NR)
Fuscidea arboricola (NR)
Hypocenomyce anthracophila (RDB EN)
H. leucococca (RDB DD)
Hypogymnia farinacea (NR)
Lecanora mughicola (NR)
Lecidea leprarioides (NR)
L. porphyrospoda (NR)
Micarea elachista (RDB EN)
M. eximia (NR)
Protoparmelia oleagina (NS)
Pycnora sorophora (RDB DD)
Xerotrema megalospora (NR)

(ii) on deciduous trees or juniper

Arthonia arthonioides (NS)
Arthopyrenia subcerasi (NR)
Arthothelium dictyosporum (NR BAP)
Bacidia igniarii (NR)
B. vermifera (RDB EN)
Buellia arnoldii (NR)
B. sanguinolenta (NR)
Caloplaca flavorubescens (RDB EN)
Catillaria globulosa (NS)
Catinaria neuschildii (RDB VU)
Fuscidea arboricola (NR)
Japewia subaurifera (NR)
Lecidella subviridis (NR)
Rinodina laevigata (NR)
Schismatomma graphidioides (RDB VU)

(NB: *Arthonia arthonioides* and *Fuscidea arboricola* appear twice, as they can occur on either pine or broad-leaved trees)
See notes to Table 9 for RDB, NR and NS categories.

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Table 11

NPIEC - Native Pinewood Index of Ecological continuity

The species listed in Table 9 are arranged in their geographical groupings, as indicated in the left column.
The Native Pinewoods for which lichen records exist, are also arranged in geographical groups, and the full name and location of each wood is given at the end of this Table.

		WESTERN GROUP									CENTRAL GROUP									EASTERN GROUP					
		Ba	Co	Lm	Be	Cg	Cc	Cr	Dd	Ac	Am	Af	Ap	Ca	Gu	Sf	Mo	Mg	Bw	Ab	Ro	Bb	Ct	Ma	Gt
	Alectoria sarmen.				D					I		K	L		N	O			R					W	
	Arthonia leucopell.	A	B	C	D			G	H	I	J	K	L		N	O	P		R	S		U			
	A. vinosa		B								J	K	L		N	O				S	T	U		W	X
	Chaen. brun/trich.	A	B	C	D	E	F	G	H		J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
W	C. chrysocephala		B		D						J	K	L		N	O	P	Q	R	S	T	U	V	W	X
I	Chrysoth. chrysoph.		B		D	E					J	K			N				R	S		U			
D	Elixia flexella		B		D					I		K	L		N	O				S				W	
E	Hypoceno. friesii	A	B	C	D	E	F	G	H	I	J	K	L		N	O			R	S	T	U	V	W	X
S	Imshaug. aleurites	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U		W	X
P	Lecidea hypopta	A	B	C	D				H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
R	L. turgidula	A		C	D							K	L	M	N	O	P	Q		S	T	U	V	W	
E	Lopadium discif.				D			G		I		K	L		N	O			R			U	V		X
A	Loxospora elatina	A	B	C	D	E	F	G		I	J	K	L	M	N	O			R	S	T	U		W	X
D	Megalaria pulverea		B	C	D					I		K	L		N	O			R				V		
	Microcalic. ahlneri		B	C			F					K	L		N					S				W	
	Mycoblastus affinis	A	B	C	D			G		I	J	K	L		N	O		Q	R	S	T	U		W	
	Pertusaria borealis				D				H	I	J					O		Q	R	S	T	U		W	X
	Protop. ochrococca	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
	Thelot. lepadinum	A	B	C	D	E		G		I	J	K	L	M	N	O			R	S		U		W	
	Xylographa spp.(2+)		B		D			G		I		K	L	M	N	O		Q	R	S	T	U	V	W	X

		WESTERN GROUP									CENTRAL GROUP									EASTERN GROUP					
		Ba	Co	Lm	Be	Cg	Cc	Cr	Dd	Ac	Am	Af	Ap	Ca	Gu	Sf	Mo	Mg	Bw	Ab	Ro	Bb	Ct	Ma	Gt
W	Calicium parvum										J	K			N				R						X
E	Cavern. hultenii	A	B	C	D			G		I	J	K	L	M	N	O			R						
S	Degelia atl./plumb.	A	B	C	D				H		J	K	L	M		O			R						
T	Hypotr. laevigata	A		C	D	E	F	G	H																
	Lobaria spp.	A	B	C	D	E		G			J	K	L	M	N	O			R	S	T		r		
&	Melasp. lentiginosul.	A	B							I															
	Micarea adnata	A	B	C	D							K	L			O			R						
C	M. alabastrites	A	B	C	D	E	F	G	H	I						O									
E	M. hedlundii		B	C	D											O									
N	M. stipitata	A	B	C	D					I															
T	M. synotheoides	A	B	C	D		F		H	I									R						
R	Pannaria s. lat. spp.	A	B	C	D	E				I	J	K	L	M		O			R	S					
A	Pert. ophthalmiza	A	B	C	D	E	F	G		I					N	O									
L	Platis. norvegica		B		D			G		I	J	K	L		N	O	P								
	Sticta spp.		B	C	D	E		G	H	I						O							r		
E	Bryoria capillaris							G			J	K	L		N	O	P		R	S	T	U			
A	B. furcellata											K	L		N	O				S					
S	Chaen. xyloxena		B													O				S	T			W	
T	Chaen'opsis pusiola											K	L		N	O			R		T	U		W	
	Cladonia botrytes																			S	T	U		W	
&	C. cenotea																			S	T	U		W	X
	Cyphelium inquin.											J	L		N	O	P		R	S	T			W	
C	C. tigillare																			S	T				
E	Lecanora cadubriae													M	N	O	P	Q	R	S	T	U	V	W	X
N	Lecidea botryosa														N					S	T	U	V	W	
T	Micarea contexta																			S	T			W	X
R	Microcal. dissemin.											K	L		N		P			S	T	U		W	X
A	Mycoblastus alpinus																				T	U		W	
L	Pycnora xanthoc.																			S	T				
	Sclero. pall./peron.							G				K	L			O			R	S	T	U		W	
	Total (full)	21	29	24	31	13	10	19	12	23	20	32	30	13	31	35	12	12	28	32	27	25	11	29	16

	WESTERN GROUP									CENTRAL GROUP									EASTERN GROUP					
	Ba	Co	Lm	Be	Cg	Cc	Cr	Dd	Ac	Am	Af	Ap	Ca	Gu	Sf	Mo	Mg	Bw	Ab	Ro	Bb	Ct	Ma	Gt
Total (widespread)	10	16	12	18	7	6	10	7	14	13	19	18	8	19	18	7	9	16	17	12	16	9	16	11

Western Group

Ba = Barrisdale (vc 97; 18(NG)/80)
Co = Coulin (vc 105; 18(NG)/95)
Lm = Loch Maree NNR (vc 105; 28(NH)/06)
Be = Beinn Eighe NNR (Coille na Glas-leitire, Allt a'Chuirn, Allt Sguabaidh & Allt na Doire Daraich) (vc 105; 18(NG)/96 & 28(NH)/06)
Cg = Cona Glen (vc 97; 17(NM)/97)
Cc = Coille Coire Chuilc (vc 88; 27(NN)/32)
Cr = Crannach (vc 98; 27(NN)/34)
Dd = Doire Darach (vc 105; 27(NN)/24)
Ac = Achnashellach (vc 105; 28(NH)/04)

Central Group

Am = Amat (vc 106; 28(NH)/48)
Af = Affric (vc 96; 28(NH)/12 & 28(NH)/22)
Ap = Affric (Pollan Bhuidhe only; 28(NH)/12)
Ca = Cannich (vc 96; 28(NH)/23 & 28(NH)/33)
Gu = Guisachan (vc 96; 28(NH)/22)
Sf = Strathfarrar (vc 96; 28(NH)/32-33-34)
Mo = Moriston (vc 96; 28(NH)/21 &28(NH)/31)
Mg = Old Wood of Meggernie (vc 88; 27(NN)/54)
Bw = Black Wood of Rannoch (vc 88; 27(NN)/55)

Eastern Group

Ab = Abernethy (vc 96; 28(NH)/91 & 38(NJ)/01)
Ro = Rothiemurchus (vc 96; 28(NH)/90, 28(NH)/80 & 28(NH)/91)
Bb = Ballochbuie (vc 93; 37(NO)/18-19, & 37(NH)/28)
Ct = Crathes (vc 92; 37(NO)/29)
Ma = Mar (vc 92; 37(NO)/09)
Gt = Glentanar (vc 92; 37(NO)/49)

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5. REFERENCES

Birse, E.L. (1971) *Assessment of Climatic Conditions in Scotland. 3. The Bioclimatic Subregions*. Craigiebuckler, Aberdeen: The Macaulay Institute for Soil Research.

Church, J.M., Coppins, B.J., Gilbert, O.L., James, P.W. & Stewart, N.F. (1996) *Red Data Books of Britain and Ireland: Lichens. Volume 1: Britain*. Peterborough: Joint Nature Conservation Committee.

Coppins, A.M. & Coppins, B.J. (2000) *Ballachuan Hazelwood, SWT Reserve, Argyll Main (VC 98) Lichen Survey II.* Unpublished report for the Scottish Wildlife Trust.

Coppins, A.M. & Coppins, B.J. (2001) *Lichen Survey of Beinn Eighe NNR Woodlands.* Unpublished report for Scottish Natural Heritage [Order No. E016379].

Coppins, A.M., Coppins, B.J. & Quelch, P. (2002) Atlantic hazelwoods: some observations on the ecology of this neglected habitat from a lichenological perspective. *British Wildlife* **14:** 17–26.

Coppins, B.J. (2002) *Checklist of British and Irish Lichens*. London: British Lichen Society.

Fletcher, A., Coppins, B.J., Hawksworth, D.L., James, P.W. & Rose, F. (1982) *Survey and Assessment of Epiphytic Lichen Habitats*. A report prepared by the Woodland Working Party of the British Lichen Society, for the Nature Conservancy Council [contract HF3/03/208].

Fletcher, A., Coppins, B.J., Gilbert, O.L., James, P.W. & Lambley, P.W. (1984) *Survey and Assessment of Lowland Heathland Lichen Habitats.* A report prepared by the Heathland Working Party of the British Lichen Society, for the Nature Conservancy Council [contract HF3/03/266].

Gilbert, O.L. (1986) Field evidence for an acid rain effect on lichens. *Environmental Pollution (Series A)* 40: 227–231.

Gilbert, O.L. (2000) *The New Naturalist: Lichens.* London: HarperCollins.

Glenn, M.G., Cole, M.S., Webb, S.L. & Hale, C.M. (1998) Corticolous lichens and bryophytes: preliminary surveys of old growth and managed northern hardwood stands in Minnesota. *In* Glenn, M.G., Harris, R.C., Dirig, R. and Cole, M.S. (eds) *Lichenographia Thomsoniana: North American Lichenology in Honor of John W. Thomson:* 407–422.

Goward, T. (1994) Notes on old growth-dependent epiphytic macrolichens in inland British Columbia. *Acta Botanica. Fennica* **150:** 31–38.

"Grey Literature" ['Surveys'] see British Lichen Society web-site: (http://www.theBLS.org.uk/)

Gustafsson, L., Fiskesjö, A., Ingelög, T., Pettersson, B. & Thor, G. (1992) Factors of importance to some lichen species of deciduous broad-leaved woods in southern Sweden. *Lichenologist* **24:** 255–266.

Hodgetts, N.G. (1992) *Guidelines for the selection of biological SSSIs: non-vascular plants.* Peterborough: Joint Nature Conservation Committee.

James, P.W, Hawksworth, D.L. & Rose, F (1977) Lichen communities in the British Isles: a preliminary conspectus. *In* Seaward, M.R.D. (ed.) *Lichen Ecology:* 295–413. London, New York & San Francisco: Academic Press.

Kantvilas, G. (1988) Tasmanian rainforest lichen communities: a preliminary classification. *Phytocoenologia* **16:** 391–428.

Kantvilas, G., James, P.W. & Jarman, S.J. (1985) Macrolichens in Tasmanian rain forests. *Lichenologist* **17:** 67–83.

Nitares, J. (ed.) (2000) *Signalarter. Indikatorer på skyddsvärd skog. Flora över kryptogamer.* Jönköping: Skogsstyrelsen.

O'Dare, A.M. & Coppins, B.J. (1992) *Mealdarroch NNR, Argyll, Lichen Survey.* Unpublished report for the Nature Conservancy Council for Scotland. [Contract No. SS/F2/285].

Orton, P.D. (1986) Fungi of northern pine and birch woods. *Bull. Brit. Myc. Soc.* **20**(2): 130–145.

Peterken, G.F. (1996) *Natural Woodland, Ecology and Conservation in Northern Temperate Regions*. Cambridge, New York & Melbourne: Cambridge University Press.

Pitkin, P.H., Lusby, P.S. & Wright, J. (1995) Biodiversity and the ecology of pinewood plants. *In* Aldhous, J.R. (ed.) *Our Pinewood Heritage* (Proceedings of a Conference held at Inverness, October 1994): 196–205. Jointly published by Forestry Commission, The Royal Society for the Protection of Birds, Scottish Natural Heritage.

Purvis, O.W., Coppins, B.J. & James, P.W. (1994) *Checklist of Lichens of Great Britain and Ireland*. London: British Lichen Society.

Rose, F. (1974) The epiphytes of oak. *In* Morris, M.G. & Perring, F.H. (eds), *The British Oak; its History and Natural History*: 250–273. Faringdon: Classey.

Rose, F. (1976) Lichenological indicators of age and environmental continuity in woodlands. *In* Brown, D.H., Hawksworth, D.L. & Bailey, R.H. (eds), *Lichenology: Progress and Problems*: 278–307. London etc.: Academic Press.

Rose, F. (1992) Temperate forest management: its effect on bryophyte and lichen floras and habitats. *In* Bates, J.W. & Farmer, A.M. (eds), *Bryophytes and Lichens in a Changing Environment*: 211–233. Oxford: Oxford University Press.

Rose, F. (1993) Ancient British woodlands and their epiphytes. *British Wildlife* **5:** 83–93.

Rose, F. (1999) Indicators of ancient woodland - the use of vascular plants in evaluating ancient woods for nature conservation. *British Wildlife* **10:** 241–251.

Rose, F. & Coppins, A.M. ['S.'] (2002) Site Assessment of Epiphytic Habitats using Lichen Indices. *In* Nimis, P.L., Scheidegger, C. & Wolseley, P.A. (eds) *Monitoring with Lichens - Monitoring Lichens:* 343–348. [NATO Science Series IV. Earth and Environmental Sciences - Vol. 7]. Dordrecht, Boston & London: Kluwer Academic Publishers.

Sanderson, N.A. (in prep.) Recolonization of epiphytic lichens after clear felling in the New Forest, Hampshire, UK. *Lichenologist*.

Seaward, M.R.D. (1995 *et sqq.*) *Lichen Atlas of the British Isles.* British Lichen Society. (Map fascicles are regularly published for genera and habitat groups).

Selva, S.B. (1994) Lichen diversity and stand continuity in the northern hardwoods and spruce-fir forests in northern New England and western New Brunswick. *Bryologist* **97:** 424–429.

Selva, S.B. (1996) Using lichens to assess ecological continuity in northeastern forests. *In* Davis, M.B. (ed.) *Eastern Old-growth Forests: prospects for rediscovery and recovery:* 35–48. Washington, D.C.: Island Press.

Tibell, L 1992: Crustose lichens as indicators of forest continuity in boreal coniferous forests. - *Nordic Journal of Botany* **12:** 427–450.

Woods, R.G. & Coppins, B.J. (in prep.) *Conservation Evaluation of the British Lichen Flora*. London: British Lichen Society.

Woods, R.G. & Orange, A. (1999) *A Census Catalogue of Welsh Lichens*. Cardiff: National Museum and Gallery Cardiff.

Wolseley, P.A. (1991) Observations on the composition and distribution of the '*Lobarion'* in forests of South East Asia. *In* D.J. Galloway (ed.), *Systematics, conservation and ecology of tropical lichens:* 217–43. Clarendon Press, Oxford.

Wolseley, P.A. & James, P.W. (1991) *A report of coastal lichen sites in England, Wales and Scotland.* Unpublished report for JNCC. [Contract No. 72-14-06d].

Wolseley, P.A. & O'Dare, A.M. (1989) *Exmoor Woodland Lichen Survey*. The Somerset Trust for Nature Conservation.

Wolseley, P.A. & O'Dare, A.M. (1990) The use of epiphytic lichens as environmental indicators in Exmoor woodlands. *Ecology in Somerset* **1:** 3–22.

APPENDIX I - Nomenclatural changes and alternatives

Advances in the taxonomic study of lichens is fast moving, and it is difficult to achieve synchrony between the national checklists and other listings, such as those included in this publication. To help with past name changes, and uses of alternative names, a list of synonyms is given below.

The Index lists and lists of 'Bonus' species follow the nomenclature in Coppins (2002). A few species mentioned as 'Bonus' species have been added to the British and Irish Flora since the publication of the previous checklist (Purvis *et al*. 1994). These are: *Buellia hyperbolica*, *Lecidea leprarioides*, *L. porphyrospoda*, *Lecidella subviridis*, *Micarea elachista, M. eximia*, *Rinodina colobinoides*, and *R. laevigata*.

The checklist of the British and Irish lichens is regularly updated on the British Lichen Society's web site (www.theBLS.org.uk), as is a list of synonyms and misapplied names (the 'Synlist'). Suggested name changes and additions to the British and Irish lichen flora are also published twice-yearly in the *British Lichen Society Bulletin* under "Literature Pertaining to British Lichens" and "New, Rare and Interesting lichens".

Column 1: Names as used in the Index tables and lists of 'Bonus' species.
Column 2: Synonyms, which may be homotypic or taxonomic synonyms or previous misapplications [these are not distinguished]. Names in *italic* type are those accepted in the checklist of Purvis *et al*. (1994).
Column 3: Cross-references to footnotes at end of this list.

Name used in this publication	Synonym(s)	Notes
Agonimia allobata	Polyblastia allobata	
Anisomeridium ranunculosporum	*Arthopyrenia ranunculospora* Arthopyrenia cinereopruinosa p.p.	2
Arthonia astroidestera	*Arthonia astroidestra*	1
Arthonia cinnabarina	Arthonia tumidula	
Arthonia ilicina	Arthothelium ilicinum	
Arthonia vinosa	Arthonia didyma pre-1980	3
Arthothelium macounii	*Arthothelium reagens*	
Bacidia vermifera	*Bacidia hegetschweileri*	
Bactrospora homalotropa	Lecanactis homalotropa	
Biatora chrysantha	*Biatora gyrophorica* Lecidea epixanthoidiza p.p.	
Biatora epixanthoides	Bacidia epixanthoides Mycobilimbia epixanthoides	
Biatora sphaeroides	Catillaria sphaeroides Mycobilimbia pilularis	
Buellia arnoldii	Hafellia arnoldii	
Buellia sanguinolenta	Hafellia sanguinolenta	
Bunodophoron melanocarpum	*Sphaerophorus melanocarpus*	
Calicium lenticulare	Calicium subquercinum	
Catinaria atropurpurea	*Catillaria atropurpurea* Biatorina atropurpurea	
Catinaria neuschildii	*Catillaria neuschildii*	
Cresponea premnea	*Lecanactis premnea*	

Name used in this publication	Synonym(s)	Notes
Degelia atlantica	Parmeliella atlantica	
Degelia plumbea	Parmeliella plumbea	
Elixia flexella	*Ptychographa flexella*	
Flavoparmelia caperata	*Parmelia caperata*	
Fuscopannaria ignobilis	*Pannaria ignobilis*	
Fuscopannaria mediterranea	*Pannaria mediterranea*	
Fuscopannaria sampaiana	*Pannaria sampaiana*	
Haematomma sorediatum	*Haematomma leprarioides*	
Heterodermia japonica	*Heterodermia obscurata* auct. brit.	
Hypogymnia farinacea	*Hypogymnia bitteriana*	
Hypotrachyna endochlora	*Parmelia endochlora*	
Hypotrachyna laevigata	*Parmelia laevigata*	
Hypotrachyna sinuosa	*Parmelia sinuosa*	
Hypotrachyna taylorensis	*Parmelia taylorensis*	
Japewiella tavaresiana	*Japewia carrollii* Japewiella carrollii Lecidea carrollii	
Lecanographa amylacea	*Lecanactis amylacea*	
Lecanographa lyncea	*Lecanactis lyncea* Opegrapha lyncea	
Lecanora sublivescens	Lecidea sublivescens	
Lobaria virens	Lobaria laetevirens	
Loxospora elatina	Haematomma elatinum	
Megalaria laureri	*Catillaria laureri* Catinaria laureri	
Megalaria pulverea	*Catillaria pulverea*	
Mycoblastus caesius	Haematomma caesium	
Mycoporum antecellens	Arthopyrenia antecellens *Arthopyrenia antecellans*	1
Mycoporum lacteum	*Tomasellia lactea*	
Pachyphiale carneola	Pachyphiale cornea	
Pannaria conoplea	Pannaria pityrea	
Parmeliella parvula	*Parmeliella jamesii*	
Parmeliella triptophylla	Parmeliella corallinoides	
Parmelinopsis horrescens	*Parmelia horrescens*	
Parmelinopsis minarum	*Parmelia minarum*	
Parmentaria chilensis	Pyrenula chilensis	
Parmotrema arnoldii	*Parmelia arnoldii*	
Parmotrema crinitum	*Parmelia crinita*	
Parmotrema reticulatum	*Parmelia reticulata* Rimelia reticulata	
Parmotrema robustum	*Parmelia robusta*	
Pertusaria pupillaris	Lecidea cinnabarina - also used for Schismatomma quercicola	4
Porina atlantica	*Porina heterospora* Porina guaranitica	5
Porina coralloidea	*Zamenhofia coralloidea*	
Porina hibernica	*Zamenhofia hibernica*	
Porina rosei	*Zamenhofia rosei* Zamenhofia ‘efflorescens’	

Name used in this publication	Synonym(s)	Notes
Pseudocyphellaria intricata	Pseudocyphellaria thouarsii agg. - also used for Pseudocyphellaria norvegica	
Pseudocyphellaria norvegica	Pseudocyphellaria thouarsii agg. - also used for Pseudocyphellaria intricata	
Punctelia reddenda	*Parmelia reddenda*	
Pycnora sorophora	*Hypocenomyce sorophora*	
Pycnora xanthococca	*Hypocenomyce xanthococca*	
Pyrenula chlorospila	Pyrenula nitida pre-1980 - also used for Pyrenula macrospora	6
Pyrenula macrospora	Pyrenula nitida pre-1980 - also used for Pyrenula chlorospila	6
Pyrenula occidentalis	Pyrenula harrisii Pyrenula neglecta	
Schismatomma quercicola	Lecidea cinnabarina - also used for Pertusaria pupillaris	7
Sclerophora pallida	*Sclerophora nivea*	
Sticta canariensis (free-living green-algal morph)	*Sticta canariensis* p.p. see next	8
Sticta dufourii [cyanobacterial morph of S. canariensis]	*Sticta canariensis* p.p. see previous	8
Thelotrema macrosporum	*Thelotrema monosporum*	
Thelotrema petractoides	*Thelotrema subtile*	
Xylographa parallela	*Xylographa parella*	1

Footnotes

1 - spelling [orthographic] correction

2. - between about 1960 and 1980, British authors used the name "*Arthopyrenia cinereopruinosa*" for what is now known as *Anisomeridium ranunculosporum*, an obligately lichenized species. There is, however, a species that correctly goes by the name of *Arthopyrenia cinereopruinosa*, but this is an apparently non-lichenized species confined to smooth bark (especially of hazel and young ash).

3 - between about 1960 and 1980, British authors used the name "*Arthonia didyma*" for what is now *A. vinosa*. The species now correctly known as *A. didyma* was at that time known incorrectly by the name "*A. lurida*" (= *A. spadicea*), or by the synonym *A. aspersella*. NB: at the same time, authors in continental Europe incorrectly used "*A. lurida*" for *A. vinosa*.

5 - there is an unresolved problem over the correct name to apply to the southern species from SW Ireland, Devon and S Wales that has been previously listed as *P. guaranitica* and *P. heterospora*. The current name is taken here to be *P. atlantica* (Erichsen) P.M. Jørg., whose type is from Tenerife in the Canary Islands.

6 - prior to about 1980, the name "*Pyrenula nitida*" as used by British authors mainly referred to *P. macrospora* and often also *P. chlorospila*. However, the true *P. nitida*, a more continental species, is present in the New Forest and at a few sites further east in southern England. It should be regarded as a 'Bonus' species when found.

7 - prior to about 1988, the name "*Lecidea cinnabarina*" was misapplied by British authors, and this species in its true sense is not correctly reported from the British Isles. The British material concerned has since been identified as either *Pertusaria pupillaris* or *Schismatomma quercicola*. These are used as alternatives in the RIEC and NIEC.

8 - Where "*Sticta canariensis*" occurs in the tables, this refers only to free-living, green-algal morphs. For the cyanobacterial (blue-green) morphs, with or without attached lobes of the green algal morph, the traditional name "*Sticta dufourii*" is used, even though this is

incorrect according to the International Code of Botanical Nomenclature. The reason for this approach, is that only the free-living, green-algal morph has Red Data Book status, and using the same name for both morphs gives rise to confusion when assessing species lists.

Index to lichen taxa

Names in *italic* type are synonyms or misapplied names, and these are dealt with in Appendix 1 (pp. 30–33).