Lichens – the Biodiversity Value of Western Woodlands

B.J. COPPINS & A.M. COPPINS

Royal Botanic Garden Edinburgh, Inverleith Row, Edinburgh EH3 5LR

Summary

The Atlantic broad-leaved woodlands of Britain are of international renown for their lichen floras. They are inhabited by 517 lichens, representing 28.3% of the total lichen flora and 73.2% of all British woodland lichens, and they are the main habitat for 165 species. Of these, 31 have a marked southern distribution and do not reach Scotland, whereas 26 species are found in Scotland, but not England or Wales. Their British Red-listed species are outnumbered by the 86 species for which Britain has International Responsibility.

Within the Atlantic broad-leaved woodlands, only 30 lichens show a preponderance for oak. With the exception of some ancient oakwoods in southern England, a high lichen biodiversity is rarely dependent on a dominance of oak in the woodland canopy, more usually it is the result of a long ecological continuity, often a varied tree and shrub composition, a varied canopy density, and good air quality. Consequently, the oak stands within former 'industrial' woodlands have a much lower lichen biodiversity compared with woodlands that have a history as 'pasture woodland' or, as with some ravine woodlands, have otherwise escaped intensive management.

The life-history of an oak tree is considered in relation to the niches it provides for lichen colonisation with time. Some management scenarios are provided with the enhancement of the lichen interest of former 'industrial' oakwoods as an objective.

Introduction

Lichens are dual organisms – each being a partnership of a fungus and an alga, or sometimes two algae. The algal partner photosynthesises and produces carbohydrates for the fungus – the fungus in turn provides shelter for the algal partner. Therefore, the lichen 'plant' or thallus acts like an autonomous green plant – and as such it is dependent on air, light and water for its growth. Variations in the quantity and quality of air, light and water for successful establishment and growth depends on the species of lichen concerned – but it can be said that very few lichens survive, or are adapted to heavily shaded conditions. In general 'Lichens like light'. However, to grow to maturity and reproduce, a lichen thallus needs a substratum that is reasonably stable to colonise. A few lichens, with short life-cycles, are adapted to ephemeral conditions, such as disturbed ground or evergreen leaves, but most require a longer-term stability provided by such substrata as tree trunks and rock faces. Variation as to 'what lichens grow on what substratum in a given situation' again depends on the species of lichen concerned – some are very fussy about where they occur – others are more catholic. For further reading on the general biology of lichens Nash (1996) and Purvis (2000) are recommended texts.

Although the Atlantic woodlands of western Britain are of international

renown among lichenologists, their lichen biodiversity has never been the subject of detailed published analysis or review. However, their lichens have been included in some studies of phytosociology and ecological continuity (James *et al.*, 1977; Rose, 1974, 1976, 1988, 1992), atlases of distribution (Seaward & Hitch, 1983; Seaward, 1995, etc.), regional floras (*e.g.* Benfield, 2001; Pentecost, 1987), taxonomic papers, and studies concerning atmospheric pollution (*e.g.* Mitchell *et al.*, 2005; Bates, 1992; Farmer *et al.*, 1991). This is not to say that the lichens of Atlantic woodlands have been little studied, indeed numerous unpublished reports regarding their biodiversity and management have been prepared for governmental and non-governmental agencies. Details of most of these reports can be found on the British Lichen Society web site (see note at end of References). Many Atlantic woodlands were included in an overview and assessment of British epiphytic lichen habitats carried out in the early 1980s by a British Lichen Society working party (Fletcher, 1982), followed by a short revision (Fletcher, 1993). This valuable exercise, which resulted in a grading of conservation importance for individual woodlands or woodland complexes, is in urgent need of updating to take account of the vastly increased knowledge accrued from more recent surveys.

In this paper, the nomenclature of British lichens follows Coppins (2002) and that for lichenicolous fungi follows Hawksworth (2003), with a few updates that appear on the *British Isles List of Lichens and Lichenicolous Fungi* on the British Lichen Society web-site (www.theBLS.org.uk) and published annually in the *British Lichen Society Bulletin*. Phytosociological nomenclature of lichen communities follows James *et al.* (1977).

An Oak Tree as a Lichen Habitat

What, during its life-history, does an oak tree in an Atlantic woodland have to offer its potential lichen colonisers. As a sapling, the oak tree has a smooth, rather shiny bark, akin to that characteristic of hazel (*Corylus*) or rowan (*Sorbus aucuparia*), and indeed at this stage our oak can carry a rather similar lichen flora. Most of the lichens have a thin, crust-like thallus, which in many cases actually grows within the outer layers of the bark. These lichens together make up communities belonging to the *Graphidion scriptae*, with species such as *Graphis scripta*, *G. elegans*, *Arthonia radiata*, *Pertusaria leioplaca* and *Opegrapha atra*. Also members of these communities are some fungi (*e.g. Arthonia punctiformis*, *Arthopyrenia analepta* and *Cyrtidula quercus*) that are traditionally treated as lichens, but which do not seem to be obligately associated with an algal partner. It is quite likely that these fungi are forming a lichen-like association, not with an alga, but with the green cells of the smooth bark. In well-illuminated situations, instead of a *Graphidion*, smooth bark can be occupied by the *Lecanoretum subfuscae*, which usually contains a high proportion of *Lecanora* spp., especially *L. chlarotera* or *L. pulicaris*.

As the sapling matures, its trunk increases in girth, and the bark of its trunk and major branches thickens and becomes rougher and fissured. The *Graphidion* lichens are gradually overgrown by other lichens with a thicker crustose thallus, or by lichens with a leafy (foliose) habit, and/or by bryophytes – these comprising communities of the *Parmelion laevigatae* or, where the bark is less acidic, the

Lobarion pulmonariae (Rose, 1988). Characteristic species of the former community include *Hypotrachyna laevigata*, *H. taylorensis*, *Menegazzia terebrata*, *Ochrolechia androgyna*, *Platismatia glauca* and *Sphaerophorus globosus*. Those of the *Lobarion* include species of *Lobaria*, *Degelia*, *Fuscopannaria*, *Nephroma*, *Pannaria*, *Peltigera* and *Sticta* spp., all with cyanobacteria as their main or secondary photobiont, as well as those with only green algae as photobiont such as *Bacidia biatorina*, *Biatora sphaeroides*, *Catinaria atropurpurea*, *Lopadium disciforme* and *Porina coralloidea*. Intermediate communities are not uncommon, and some species are mainly found in such assemblages, *e.g. Phyllopsora rosei* (Fig. 1c). Especially on the upper trunk or branches, where bryophytes are at a disadvantage, there may be a dominance of shrubby or beard-like (fruticose) lichens of *Usnea* and *Ramalina*, constituting the *Usneion barbatae*. However, the tree, while it remains alive, can continue to support lichens of the *Graphidion* or the *Lecanoretum subfuscae* on the smooth bark of its twigs and younger branches – even though these may be out of reach of the prospecting lichenologist! In certain situations other communities can be found. For example, the rugged bark of old trees, if rarely wetted, can be occupied by the *Lecanactidetum premneae* with species such as *Cresponea premnea*, *Lecanographa lyncea* and *Schismatomma decolorans*. This community is very rare in Scotland, and is most abundant in the lower rainfall areas of SW England.

In oceanic woodlands, a high bryophyte cover is often quickly established on the trunk and older branches of the tree. These bryophytes compete with space for those lichens that need to become established directly onto the bark, and many lichens that are abundant on oaks in the drier woodlands of eastern Scotland, are either absent, or are much scarcer in the west. However, a high bryophyte cover is not disadvantageous to all lichens, as there are many that can grow over bryophytes and, indeed, there are some lichens that require a bryophyte mat on which to become established. A disadvantage for lichens that do well on bryophyte mats is that these mats are prone to peeling off during times of heavy rain and high winds – taking the lichens with them!

The mature tree has many lichens of different persuasions on its lower and upper trunk (and maybe on different sides of the trunk), its boughs, branches and twigs. However, the lichen biodiversity can be different, often with an increase in species, if additional niches are provided. Some ways in which this can occur are:

- the tree has a leaning rather than a vertical trunk;
- it grows on a steep bank with exposed larger roots and associated hollows;
- it has dead boughs providing niches for lignicolous specialists;
- it has splits or wounds providing sap runs, which can alter the physiochemical properties of the bark.

In Atlantic woodlands the number of lichen species occurring on a single, mature oak can vary from about 20-50, but figures exceeding 80 have occasionally been recorded on large, recently fallen trees in wood pasture or parkland, where there has been an opportunity to closely study the upper bole and canopy.

Even after death the oak tree has much to offer. The trunk of a fallen tree, with or without its bark on, can provide a habitat for large leafy lichens, *e.g.*

Peltigera spp., or for *Cladonia* spp. The upended root-plate can also provide niches for a range of species both on the tree roots and on the associated soil and stones. A decorticated fallen trunk, if not too shaded, can host many lignicolous lichens, some of which are specialists of hard lignum, and are otherwise mostly found on old pine 'bones', *e.g. Calicium glaucellum*, *C. lenticulare* (Fig. 1a), *Chaenotheca brunneola*, *Ptychographa xylographoides* and *Xylographa vitiligo*. These same specialists can also grow on standing, decorticate trunks, and large decorticate trunks can be in that condition for many decades, providing a 'prime' lichen habitat – but such 'hulks' are usually rare in our Atlantic Woodlands, as are veteran, living oaks.

The lichen flora of our tree depends on its age and its 'architecture'. It will also depend on the situation and surroundings of the tree – be it woodland edge, just in from the woodland edge, at the top of knoll, the side of a knoll or valley, or at the bottom of a ravine, etc. Similarly, the density of the surrounding canopy and proximity of other trees and density of an understorey.

The Resource

By September 2005, the number of lichens known from the UK totalled 1884 (Coppins, 2002; and updates on the BLS website), of which 779 occur commonly or exclusively as epiphytes growing on bark or lignum. A few of these epiphytes are rarely if ever found in woodland, being restricted to such habitats as wayside trees, worked timber in open situations, and the stems of submontane or montane subshrubs. The number of woodland lichens is about 706, and 517 of these are reported from woodlands in the Atlantic zone. The Atlantic zone is here defined as areas experiencing more than 160 raindays (Coppins, 1976; Ratcliffe, 1968), and/or with an Index of Climatic Oceanicity of 15 or more (Averis *et al.*, 2004), both approximating to areas having an annual rainfall of 1000 mm or more. Woodlands (and some ancient parklands) in this zone provide the main habitat for 165 epiphytic lichens, but all these lichens are not evenly distributed throughout the zone (Fig. 1). For example, within Britain, 26 species are known only from Scotland, whereas 31 species, which have a southern Atlantic or southern European distribution, are apparently absent in Scotland but present in England and/or Wales. There are a few enclaves for oceanic lichens outwith the main Atlantic zone, the most notable of which are within the New Forest in Hamphire (Rose & James, 1974). The above numbers do not include Ireland which, however, has five epiphytic species (*Haematomma sorediatum*, *Julella sericea*, *Leptogium juressianum*, *Porina atlantica* and *Strigula tagananae*), all from western Ireland, that have not been recorded from Britain.

Lichens with an Affinity to Oak

Of the 165 epiphytic lichens that are mainly confined to the Atlantic zone, only about 30 have a strong affinity to oak (Table 1), and half of these species are either absent or very rare in the Atlantic woodlands of Scotland. With the exception of *Bactrospora dryina*, *Biatora vernalis* and *Strigula thelopsidoides*, the remaining species, although well represented in Scotland, have stronger populations in England and Wales. This is in marked contrast to many species of the *Graphidion* and *Lobarion* communities that are more often found on trees other than oak and

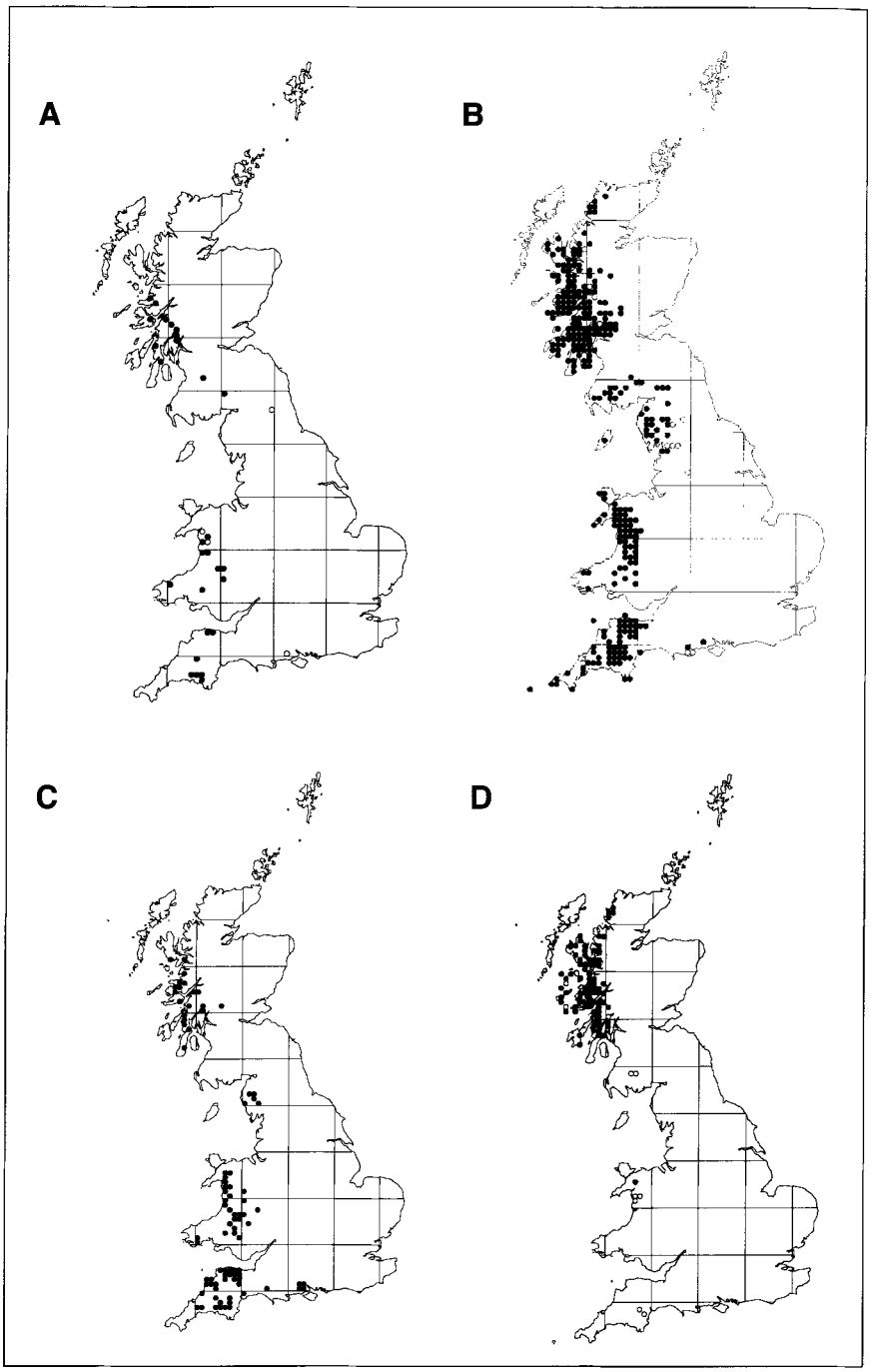

Fig. 1. British distributions of four characteristic lichens of Atlantic woodlands: A, *Calicium lenticulare*; B, *Hypotrachyna laevigata*; C, *Phyllopsora rosei*; D, *Pseudocyphellaria norvegica*. Data from the British Lichen Society Mapping Scheme, prepared using DMap.

Table 1. Atlantic woodland lichens with a preference for oak.

Throughout most of Atlantic Woodland zone:	**Very rare in Scotland:**
*Arthonia vinosa	Agonimia octospora
Bacidia biatorina	Cresponea premnea
Biatora vernalis	Lecanographa lyncea
Calicium lenticulare	Lecanactis subabietina
Lecidea doliiformis	Lecanora quercicola
Opegrapha fumosa	Rinodina isidioides
Opegrapha xerica	Rinodina roboris
*Pachyphiale carneola	Usnea ceratina
Phyllopsora rosei	
Porina coralloidea	**Absent from woodlands in Scotland:**
Porina hibernica	Blarneya hibernica
*Schismatomma quercicola	†Bryoria bicolor
Thelopsis rubella	Bryoria smithii
	Calicium hyperelloides
Confined to Scotland:	Melaspilea amota
Bactrospora dryina	Opegrapha corticola
Strigula thelopsidoides	Porina effilata

*Preference for oak less strong in Scotland than further south.

†Presence in Scotland confined to rock outcrops and large boulders outwith woodlands.

which have Scotland as their 'headquarters' within the British Isles (*e.g. Degelia atlantica*; Rose & Coppins, 1999), Europe (*e.g. Pseudocyphellaria norvegica*; Fig. 1d) or the world (*e.g. Graphis alboscripta*; Coppins *et al.*, 2002).

Conservation Evaluation

The threat status of British lichens was first evaluated by Church *et al.* (1997), and later updated and expanded upon by Woods & Coppins (2003). The number of species with a 'Red List' status is rather few, but this contrasts strongly with the number of species for which the UK is currently considered to have 'International Responsibility' (Table 2; Coppins 2003). This highlights the international importance of our Atlantic woodlands for their lichen biodiversity.

Lichenicolous Fungi

Lichens are associated with other organisms, other than those on which they grow. They are a source of food, shelter or camouflage for many invertebrates (Gerson & Seaward, 1977), and similarly for several vertebrates (Richardson & Young, 1977). Many lichens are parasitised by specialist fungi, which are often host-specific to a lichen genus or species, and about 400 such fungi are currently reported from the British Isles (Hawksworth, 2003, 2004). Table 3 lists 36 lichenicolous fungi which are mainly to be found in Atlantic woodlands, even if their host species (*e.g. Thelotrema lepadinum*) may often occur outside the Atlantic zone.

Table 2. Numbers of species of conservation concern among epiphytic lichens that are mainly confined to Atlantic woodlands (adapted from Woods & Coppins, 2003).

Status	UK	Scotland only	England and/or Wales only
Critically endangered	9	3	6
Endangered	4	2	2
Vulnerable	13	3	5
Data deficient	10	3	4
Near threatened	40	9	10
International responsibility	86	19	15

What are the Attributes of a 'Good Wood' for Lichens?

The number of epiphytic lichens found in individual Atlantic woodlands mainly falls within the range of 100-200 species, although lower and higher totals are sometimes recorded. The importance to biodiversity of variation in the age, architecture and situation of an oak tree was outlined above. In addition, the lichen biodiversity of a woodland potentially increases with a greater number of companion trees – only in exceptional woodlands, such as Black Tor Copse and Wistman's Wood on Dartmoor, is a high lichen diversity largely dependent on a canopy dominance of oak (Coppins & Coppins, 2003a, 2003b). All trees and larger shrubs differ in their characteristics, *e.g.* longevity, architecture, canopy density and bark properties (Barkman, 1958). Oaks can reach a great age of several hundred years, and their exposed wood (lignum), if well ventilated, is naturally resistant to decay and can persist for decades or longer. When mature, the bark of an oak trunk is rough, fissured and of a fairly low pH. The bark of ash (*Fraxinus excelsior*) also becomes rough and fissured, but generally has a higher pH, and the tree canopy is lighter – these conditions providing niches for many lichens that are rarely found on oak. Negative attributes of ash are that the trees are generally not so long-lived, and its lignum rots much more quickly. In a similar vein are the different attributes of, for example, alder (*Alnus glutinosa*), aspen (*Populus tremula*), birch (*Betula* spp.), elm (*Ulmus glabra*), gean (*Prunus avium*) hazel, hawthorn (*Crataegus monogyna*), holly (*Ilex aquifolium*), rowan and willows (*Salix* spp.).

The lichen habitats within a woodland are not confined to the trees themselves, but may also include rock outcrops of varying size, aspect and geological properties, boulders, rocks and boulders in and alongside streams, and peaty banks. These features can all add considerable lichen interest to a site. Some characteristic saxicolous lichens of Atlantic woodlands are *Herteliana gagei*, *Lecidea ahlesii*, *Opegrapha saxigena*, *Porina ahlesiana*, and *Schismatomma umbrinum*.

Natural and semi-natural woodlands did not appear on our landscape, as they look today, *de novo*. They have developed and changed since their origins – they are dynamic habitats, as are the populations of their associated flora and

Table 3. Lichenicolous fungi for which Atlantic woodlands are the main habitat.

Lichenicolous fungus	Fungal group	Host(s)
Abrothallus welwitschii	A	Sticta spp.
Arthonia cohabitans	A	Arthothelium macounii
Arthonia columbiana	A	Cladonia spp.
Arthonia graphidicola	A	Graphina anguina, Graphis scripta
Arthonia invadens	A	Schismatomma quercicola
Arthonia thelotrematis	A	Thelotrema lepadinum
Capronia normandinae	A	Normandina pulchella
Clypeococcum cladonema	A	Cetrelia olivetorum s. lat.
Corticiruptor abeloneae	A	Sticta dufourii
Dactylospora lobariella	A	Lobaria pulmonaria
Hemigrapha atlantica	A	Sticta dufourii
Kalchbrenneriella cyanescens	C	Usnea spp.
Myxophora leptogiophila	A	Collema subflaccidum
Nanostictis christiansenii	A	Lobaria pulmonaria
Nectriopsis lecanodes	A	Lobaria spp. and other Peltigeraceae
Niesslia lobariae	A	Lobaria pulmonaria
Nigromacula uniseptata	C	Hypotrachyna laevigata and H. sinuosa
Opegrapha brevis	A	Thelotrema petractoides
Opegrapha pertusariicola	A	Pertusaria leioplaca
Opegrapha thelotrematis	A	Thelotrema lepadinum and T. macrosporum
Plectocarpon lichenum	A	Lobaria pulmonaria
Plectocarpon sampaianae	A	Fuscopannaria sampaiana
Plectocarpon scrobiculatae	A	Lobaria scrobiculata
Pronectria fissuriprodiens	A	Lobaria pulmonaria
Psammina lobariae	C	Lobaria pulmonaria
Refractohilum galligenum	C	Nephroma laevigatum
Roselliniella nephromatis	A	Nephroma and Pseudocyphellaria spp.
Sclerococcum normandinae	C	Normandina pulchella
Skyttea caesii	A	Mycoblastus caesius
Skyttea nitschkei	A	Thelotrema lepadinum
Skyttea pyrenulae	A	Pyrenula occidentalis
Stigmidium degelii	A	Degelia atlantica and D. plumbea
Toninia plumbina	A	Degelia plumbea
Tremella coppinsii	B	Platismatia glauca
Tremella lobariacearum	B	Lobaria pulmonaria
Unguiculariopsis manriquei	A	Lobaria pulmonaria

(NB: There are many more of these fungi that await formal description.)
Fungal groups: A = ascomycete; B = basidiomycete; C = conidial fungus

fauna. In a given geographical area and under given macroclimatic conditions, some lichens are easily dispersed and established, while others are much more tardy in this respect. Most of our natural or semi-natural wooded habitats are centuries or even millennia in age, and have had the potential to acquire and retain a large number of lichens under different climatic regimes.

That most of our currently or previously enclosed woodlands fall far short of expressing this potential today, is largely a result of the effects of man. For most of our Atlantic Woodlands this is not the result of atmospheric pollution (which has devastated woodland lichens in many other regions) – but of the type and scale of woodland management. To acquire and, above all, to retain a high lichen biodiversity, a continuity of available substrata is required. If all the mature and veteran trees in a wood are felled, then the lichens requiring the niches such trees provide will be removed as well. Similarly, if a stand of hazel is clear-coppiced, all the lichens of that habitat will be removed. On the other hand, a wood that has been managed much less intensively with regard to the scale of tree or stem extraction, will be able to retain all or most of its lichen interest.

Indices of Ecological Continuity

At a forerunner to this meeting, in 1973, Francis Rose introduced his 'Index of Ecological Continuity' as a tool to identify ancient woodlands or parklands with a long ecological continuity (Rose, 1974). By ecological continuity, he meant, habitats that had a long history of the continual presence of mature and veteran trees. His 'Index' was not intended for use in coppiced woodlands, such as those found in SE England – even though these may have ancient origins. Francis Rose, soon after, modified his IEC to the still now much used 'Revised Index of Ecological Continuity' (RIEC). This was developed further into regional indices – with the 'West of Scotland Index of Ecological Continuity' (WSIEC) and 'Eu-Oceanic Calcifuge Index of Ecological Continuity' (EUOCIEC) being the most applicable to Atlantic Woodlands in high rainfall areas, and the 'New Index of Ecological Continuity' (NIEC) also applicable to lowland woodlands in somewhat lower rainfall areas of SW Scotland, W Wales and SW England (Coppins & Coppins, 2002a; Hodgetts, 1992; Rose, 1976, 1992).

Most of our Atlantic 'oakwoods' have low lichen biodiversities and low 'Index' scores. This is because most of these woods have an industrial history and have been totally or largely clear-felled at least once during the last 200 years, and many of the companion trees and shrubs were almost eradicated during the period of 'industrial' management. However, some of these woods do have associated relict stands, *e.g.* groups of trees and shrubs (not necessarily of oak) on steep rocky knolls or on the sides of ravines, as boundary markers, or in adjacent areas with a long history as pasture woodland.

Many woodland Sites of Special Scientific Interest (SSSIs) were originally drawn up in the 1960s and 1970s on established boundaries as appear on maps; these boundaries often being the enclosures (or former enclosures) around coppiced oakwood. This practice of defining SSSI boundaries unfortunately resulted in many important relict areas being excluded from statutory protection. The increasing recognition of the biodiversity importance of pasture woodlands (Harding & Rose, 1986; Stiven & Holl, 2004) is gradually resulting in some redress to this situation, but much more needs to be done. Using two Indexes of Ecological Continuity, Table 4 gives an example of the huge importance of an area lying just outside a SSSI in North Devon (Exmoor).

Table 4. Comparison of lichen 'Index' scores between former oak coppice within a SSSI and adjacent pasture woodland outside the SSSI. The site is High Farley Wood, within Watersmeet SSSI, Exmoor (North Devon). Data summarised from Coppins & Coppins (2002b).

Status	RIEC	NIEC
Within SSSI (enclosed former oak coppice)	10*	3†
Outwith SSSI (adjacent pasture woodland)	70	28

* Sites with a score of <25 are considered to show little if any sign of ecological continuity.
† Sites with a score of <20 are considered to be likely of limited conservation importance for their lichen interest.

The Future

So, what of the future of our Atlantic oakwoods as a habitat for lichens? With time, they should regain some of their 'lost' species, especially where such species persist in associated or nearby relict habitats, but this could take several hundreds of years, by which time the woods will probably look very different, and may no longer be 'oakwoods' as such – rather mixed broad-leaved woodland – which is probably what they were in the first place! Indeed, the acquisition of 'new' lichens will depend on the changes that bring about this 'new look'. Such changes could include: the gradual opening up of long-term gaps in the canopy, thus providing gradients of illumination and ventilation; the accumulation of large-sized dead-wood; and the increase in proportion of other trees and shrubs.

If these woods are to be maintained for the prime purpose of nature conservation, this does not mean that a wholly 'non-intervention' approach is recommended. The woods should be grazed to appropriately control regeneration, including prevention of excessive regeneration of holly, for example, but not so intensively or continuously to inhibit any regeneration (even of holly!). Also, the temptation to infill gaps with planted trees in 'tubes' should be resisted. Such management regimes and the consequent changes to woodland structure and diversity should ensure a healthy future for many of our Atlantic woodlands. However, all best intentions will come to naught if the scourge of *Rhododendron ponticum* s.lat. is not removed from our landscapes. For lichens, allowing *Rhododendron* to spread rampantly through a wood is tantamount to clear felling it!

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Note: Bibliographic information on unpublished surveys and other 'grey' literature pertaining to the lichens of Great Britain and Ireland can be found under 'Catalogue of unpublished lichen grey literature and related works' on the British Lichen Society's web site: htttp://www.theBLS.org.uk.