THE LICHEN FLORA OF HULL, WITH PARTICULAR REFERENCE TO ZONAL DISTRIBUTION AND ENVIRONMENTAL MONITORING

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INTRODUCTION

The role of lichens as environmental monitors is widely recognised. Not only are they valuable as indicators of habitat stability and environmental continuity, but they are also effective in monitoring environmental quality, more particularly air and soil (and more recently water) pollution. In the past, the main role of lichens in this context has been to monitor sulphur dioxide air pollution, especially stable and rising levels (Seaward 1993). However, it has also been shown that lichens are effective monitors of falling levels of gaseous sulphur dioxide and indeed of other pollutants, some of which are manifesting themselves as a consequence of the reduction in the former; of particular interest in this respect is the use of lichens to detect and determine the extent of qualitative changes in air pollution such as the impact of acid rain and hypertrophication (Seaward 1997; Seaward & Coppins 2004).

HISTORICAL CONTEXT AND BASELINE SURVEYS

The establishment of baseline information through detailed lichen surveys adopting rigorous protocols is crucial for such monitoring programmes. Despite the establishment of an elaborate national database of lichen mapping by the British Lichen Society in 1963, Hull has received limited coverage; furthermore, little is known of its lichen flora prior to this date as it appears to have been overlooked by naturalists and at Yorkshire Naturalists' Union field meetings despite the county having 300 years of lichenological recording (Seaward 1987). Only one record specifically localised to Hull has been found in published or herbarium sources, namely *Ramalina siliquosa*, represented by a specimen (now in Dublin herbarium) collected by W. G. McIvor in 1844-45 (Seaward 1976); this is a interesting record since this species is found on maritime rocks (and occasionally timber); even today, this species is rare in eastern England north of the Humber and absent to the south of it.

During 1967 to 1970, B. J. Coppins, then an undergraduate at the University of Hull, produced a preliminary list of East Yorkshire lichens, but this contains only a few species for the city. Later, D. H. Smith visited the city as part of the BLS national churchyard survey, listing 17 species at Sutton-on-Hull in 1990 and 17 species at Hull Spring Bank (Western Cemetery) in 1995. However, this earlier work was almost entirely based on studies of saxicolous species and so does not provide an adequate baseline from which to gauge any form of environmental impact other than the total disappearance of the particular habitat studied.

However, a better picture of the lichen flora in the rural areas surrounding the city (i.e. within 5 km of its boundary, see below) can be determined from work undertaken mainly by B. J. Coppins, D. H. Smith and M. R. D. Seaward over the past 35 years; this can be used for comparative purposes in the evaluation of the city's current and potential biodiversity.

CURRENT SURVEYS

Three days of intensive fieldwork by the author in February 2002 provided credible baseline data for (1) judging the current status of the city's lichen flora and determining the major factors affecting it, and (2) critically evaluating future impacts, deleterious or favourable, on that flora; this work was followed up by several day visits by the author in 2003 and 2004. The survey work undertaken in 2002 was presented as an unpublished report to the Hull Biodiversity Partnership (Seaward 2002) and the preliminary conclusions used in the lichen section of the *Hull Local Biodiversity Action Plan* (Marshall 2002).

There was clear evidence from this work that the city's lichen flora reflected atmospheric amelioration in terms of sulphur dioxide (complementing data derived from pollution gauges: see Kingston upon Hull City Council 2000, section 3.5), but also showed increased hypertrophication. Both these processes, which are widespread in Britain, and indeed Europe, have been detected by lichenological surveys (Seaward 1993, 1997; Seaward & Coppins 2004), but their stage of development cannot be accurately gauged for Hull due to the limited baseline information. The implementation of clean air policy and practices has undoubtedly impacted on the city's lichen flora as measured by the increase in biodiversity, particularly of epiphytic species, but there has also been a qualitative (as well as quantitative) shift, the prevailing species in a wide variety of habitats being reflective of extensive hypertrophication.

These surveys investigated a wide variety of habitats: corticolous (tree trunks and twigs) and saxicolous (stonework, brickwork, cement and other man-made substrata) proved most rewarding, but muscicolous (over mosses) and lignicolous (timber), even when impregnated with nutrient-enriched (mainly nitrogenous) dusts, were disappointing, and terricolous (on soil) species were non-existent.

The fieldwork was based on zonal and transect studies, the former radiating from the old city centre, and the latter extending (according to accessibility) more-or-less along five compass points to the W, NW, N, NE and E; in each case as many of the above-named habitats/substrata as possible were investigated, but most attention was paid to epiphytes.

In all, 54 taxa were recorded by the author from the city during the past two years (Appendix A), which compares favourably with the biodiversity (155 taxa) of the lichen flora of the surrounding rural areas within 5 km of the city boundary.

Zonal Study

On the basis of the epiphytic flora, the city can be clearly demarcated into three zones (Figure 1): an **inner zone (I)** of 1 to 4 species, an **intermediate zone (II)** of 5-8 species, and an **outer zone (III)** of more than 8 species; the variation in biodiversity within a zone and the abundance/percentage cover on a particular substratum are related to air quality in general and more particularly to the level of hypertrophication. Further variations relate to (a) habitat, mainly exposure *v.* shade, (b) tree species, (c) vandalism, and (d) inclination of the trunk. Many commonly planted trees, such as plane, beech, cherry and hawthorn are poor for lichens. Trees at a slight angle to the vertical often provide a more favourable habitat for epiphytes. In the past, only mature trees would be examined in such surveys, but, rather interestingly, some relatively young trunks occasionally support several species; similarly, twigs, also previously overlooked in urban surveys, should be examined since they frequently support species indicative of hypertrophication (Seaward & Coppins 2004).

As well as diversity counts, attention was also paid to the height to which particular species, and lichens in general, reached on the trunk; in both cases, these measurements were important in defining pollution zones, and with a more elaborate definition could be used to subdivide the three zones mentioned above, but the level of hypertrophication requires qualification as it complicates factor interpretation.

Generally speaking, the epiphytic flora of the **inner zone (I)** is composed of one alga (*Pleurococcus*) and one or two ill-defined crustose species, including *Lecanora conizaeoides* (often infected by the fungus *Athelia arachnoidea*); however, it must be pointed out that *L. conizaeoides*, which for the past 50 years has dominated urban environments, is now on the decline (in Hull it is only occasionally found in fruit, mainly when growing on timber fencing); additionally, according to the level of hypertrophication, one or more of the following foliose species are to be found: *Physcia adscendens*, *Phaeophyscia orbicularis* and *Xanthoria parietina*, and rarely (e.g. Victoria Pier) *X. polycarpa*.

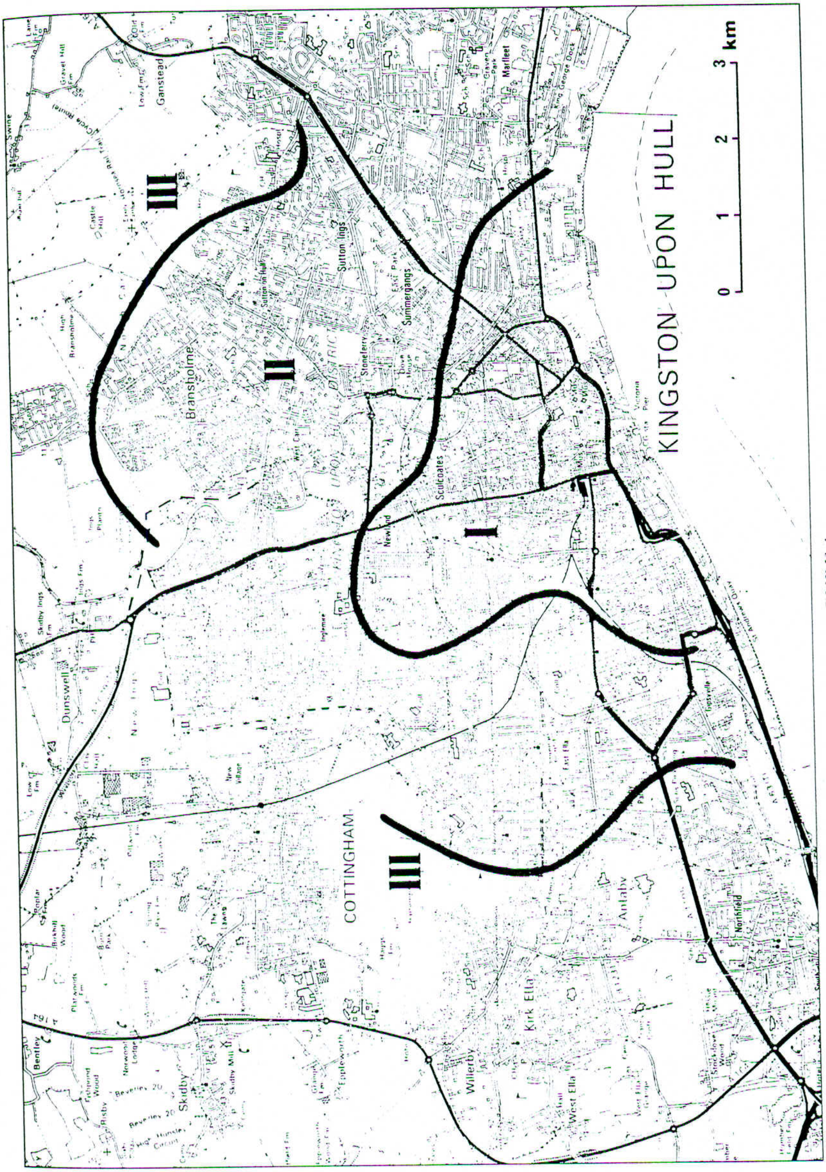

FIGURE 1.

Kingston upon Hull: air quality zones (I to III, with decreasing air pollution burdens) delimited on the basis of lichen surveys, February 2002-February 2004 (superimposed on 1992 OS map, with permission).

The epiphytic flora of the **intermediate zone (II)** is composed of all of those species found in the inner zone together with *Parmelia sulcata* (rarely *Hypogymnia physodes* and/or *Lecanora expallens*) and, according to the level of hypertrophication, one or more of the following: *Lecanora dispersa* and *L. muralis* (tree bases only), *Physcia caesia*, *P. tenella*, *Physconia grisea* and *Xanthoria candelaria*.

The epiphytic flora of the **outer zone (III)** is composed of all of those species found in the inner and intermediate zones (although *Pleurococcus* and *Lecanora conizaeoides* are less frequently encountered), with the addition of one or more of the following: *Amandinea punctata*, *Candelariella reflexa*, *Evernia prunastri*, *Flavoparmelia caperata*, *Hypotrachyna revoluta*, *Melanelia fuliginosa* ssp. *glabratula*, *M. subaurifera*, *Punctelia ulophylla*, *Phlyctis argena* and *Ramalina farinacea*.

In terms of the radial transects, the lichen flora (particularly the epiphytes) significantly improves with distance from the centre of the city in all directions, with the exception of the easterly route where only a marginal improvement was detected; it was also noticeable that along the westerly route the epiphytic flora improved almost to the optimum detected anywhere in the city, only to decline at *c*. 200 m from the city boundary approaching Hessle.

This survey work was undertaken at a critical time in terms of the recovery of the city's lichen flora, as demonstrated by the short-term shifts in distribution and habitat extension within the space of only two years. It should be noted that urban environments provide an artificially high and remarkable array of habitats and substrata, and that once the prevailing factor (air pollution) dictating the lichen flora has been alleviated, such an environmental diversity will naturally be exploited by lichens.

Although much of the work concentrated on the epiphytic flora, attention was also paid to the wide variety of other substrata to be found in urban environments. Currently, urban distribution patterns are less easily discerned for those species found on saxicolous and lignicolous substrata, although biodiversity counts in particular habitats and autecological studies of selected species (e.g. *Lecanora muralis*) have proved useful in the past for bioindicational scales of air pollution monitoring (Seaward 1976a). In all, 24 saxicolous and one lignicolous species were recorded, but it should be noted that many of the former were also to be found on dust impregnated (often nutrient-enriched) living and dead wood substrata. Truly maritime species on shoreline sea defences (stone- and timber-work) were not encountered and maritime influences on the lichen flora in general were undetectable; no terricolous species were recorded during the current surveys.

A complete inventory of the 54 lichens recorded on this survey is provided in Appendix A, together with details of the zones (I, II and III) in which they occur, the substrata on which they were recorded and some level of overall frequency.

CONCLUSIONS

Despite there being no previous baseline study, it is clear from this work that the lichen flora of Hull is undoubtedly recovering as a result of atmospheric amelioration, and that future recolonisation studies of particular species and assemblages will be rewarding in order to determine air quality, the extent of hypertrophication and other human disturbances. Although there are no Red Listed lichen species in need of conservation action, there are habitats supporting relatively rich and improving lichen floras which merit special consideration, such as the mature trees and thickets on golf courses and on roadsides with wide verges. The diverse lichen floras associated with some of the city's older buildings (e.g. churchyards and old brickwork) should also be considered in terms of their lichenological as well as historical value. Rejuvenation areas are also not without lichenological interest, particularly those along the coastline where, for example, the harshness of building work will be softened over time by a mosaic of lichens. Due to their longevity, lichens could also be suitable for monitoring the stability of sea defences.

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APPENDIX A.

Checklist of lichens currently recorded by the author, 2002-2004, within Hull city boundaries, with details of zonal distribution (I, II, III – see text), substrata and frequency

Acarospora fuscata I, II, III, brickwork & acid stone, occasional
Amandinea punctata III, tree trunks, occasional
Caloplaca citrina I, II, III, calcareous substrata, locally frequent
C. decipiens I, II, III, calcareous dusty substrata, infrequent
C. flavescens II, III, calcareous substrata, uncommon
C. flavocitrina I, stone sea defences, locally frequent
C. holocarpa II, III, calcareous substrata, occasional
C. saxicola I, II, III, calcareous substrata, occasional
Candelariella aurella I, II, III, calcareous substrata, locally frequent
C. reflexa III, tree trunks, occasional
C. vitellina I, II, III, acid stonework, locally frequent
Catillaria chalybeia I, tops of timber wave breakers, rare
Evernia prunastri III, tree trunks, infrequent
Flavoparmelia caperata III, tree trunks (mainly *Salix*), occasional
Hypogymnia physodes I (very rare), II, III, tree trunks, occasional
Hypotrachyna revoluta III, tree trunks (mainly *Salix*), rare
Lecania erysibe I (coastal), II, III, calcareous substrata, occasional
Lecanora albescens I, II, III, calcareous substrata, locally frequent
L. campestris II, III, calcareous substrata, occasional
L. conizaeoides I, II, III, tree trunks, timber, stonework, etc., common (but declining)
L. crenulata I (rare), II, III, calcareous substrata, occasional
L. dispersa I, II, III, calcareous substrata, locally common (rarely on bases of trees)
L. expallens I (very rare), II, III, tree trunks, infrequent but widespread

L. muralis I, II, III, stonework, cement & tree bases, locally frequent
L. polytropa II, III, acid stonework, occasional
Lecidella scabra I, II, III, stonework, infrequent
L. stigmatea I, II, III, calcareous stonework, locally frequent
Lepraria incana s.l. I, II, III, tree trunks & acid stone, locally frequent
Melanelia fuliginosa ssp. *glabratula* III, tree trunks & branches, infrequent
M. subaurifera III, tree trunks, occasional
Parmelia sulcata I (very rare), II, III, tree trunks, infrequent
Phaeophyscia nigricans II, III, calcareous substrata, occasional
P. orbicularis I, II, III, tree trunks, stonework, etc., very common
Phlyctis argena III, tree trunks, rare
Physcia adscendens I, II, III, tree trunks, very common (rarely on calcareous substrata)
P. caesia I, II, III, tree trunks & stonework, locally frequent
P. dubia III, tree trunk bases, infrequent
P. tenella I (less frequent), II, III, tree trunks, locally frequent
Physconia grisea I (very rare), II, III, tree trunks, occasional
Porpidia soredizodes II, III, acid stonework, rare
P. tubulosa II, III, acid stonework, infrequent
Psilolechia lucida II, III, acid stonework, occasional
Punctelia ulophylla III, tree trunks (mainly *Salix*), rare
Ramalina farinacea III, tree trunks & branches, rare
Rinodina gennarii I, II, III, stonework & brickwork, infrequent
Scoliciosporum chlorococcum II, III, tree trunk bases, occasional (but overlooked)
S. umbrinum II, III, calcareous substrata, occasional
Trapelia coarctata II, III, acid stonework, infrequent
Verrucaria macrostoma f. *furfuracea* II, III, calcareous substrata, occasional
V. muralis II, III, calcareous substrata, infrequent (probably overlooked)
V. nigrescens II, III, stonework, infrequent (probably overlooked)
Xanthoria candelaria II, III, tree trunks (especially bases), locally frequent
X. parietina I, II, III, tree trunks & twigs, stonework, etc., common
X. polycarpa I (rare), II, III, tree trunks and twigs, infrequent but widespread