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Part I: Lichen Mapping Projects in Europe
1. National Projects

Twenty-five Years of Lichen Mapping in Great Britain and Ireland

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With 2 figures and 1 table

Abstract

The progress of the Mapping Scheme of the British Lichen Society, which was initiated in 1964, is reviewed. The evolving methods of data collection, data storage, and map production are described. The first maps were published in 1971 and the first volume of an atlas in 1982. The computer systems now in use provide a wide variety of outputs, including camera-ready maps for printing, microfiches, and colour graphics. In the future, capability to sort by date and site features should be included, and the systems used be designed to be compatible with those developed for other groups of plants.

1. Introduction

The recording of lichens in Great Britain and Ireland has largely followed procedures first introduced for flowering plants and ferns. The system of recording by numbered vice-counties, introduced for mainland Britain by H. C. Watson (1847–59) and extended to Ireland by Praeger (1896), was adopted by W. Watson (1953) for lichens. This tradition has been continued for Ireland (Seaward 1984), but a project to up-date Watson's data for the rest of the British Isles by A. E. Wade (1895–1989) was never completed.

Although the vice-county system provided 152 mapping units, this number proved to be far too few to provide a basis for the establishment of correlations between distributions and edaphic or climatic factors. In April 1954, the Botanical Society of the British Isles initiated a mapping scheme based on 10 km × 10 km grid squares. Mapping cards were designed, converted to individual punched cards, and used to print dot-maps on a modified mechanical tabulating system (Allen 1986). The scheme proved immensely attractive to amateur botanists. The main atlas, published in 1962, included 1.700 maps and 12 overlays (Perring & Walters 1962).

This success stimulated one of us (M.R.D.S.) to propose in 1963 that the British Lichen Society, which had only been founded in 1958, start its own Distribution Maps Scheme. This was approved and launched in August 1964, even though some members were very sceptical that it could ever succeed. By the early 1970s, the Scheme was permeating many areas of the Society's activities, providing a focus for field meetings, promoting studies on herbaria and literature, and acting as a unifying agent between amateur and professional lichenologists. Now that the euphoria surrounding the publication of the first atlas (Seaward & Hitch 1982) has waned, it is appropriate to reflect on the achievements in the quarter of a century since the Scheme was launched, the lessons which have been learnt, and ways in which the Scheme can be developed in the years ahead.

2. Data collection

At the outset, the basic data collection was on cross-off mapping cards. The 1964 card had the names of only 154 species printed on it, selected mainly on the basis of ease of identification; many of the included species were extremely rare and users had to add other names by hand, often extending to attached sheets of paper. These cards were unpopular, and it was not until after the issue of a more practical card in 1968 which included 728 species and followed a new introductory lichen flora (Duncan 1970) that data collection started to accelerate. This card stood the test of time and was not revised again until after the publication of a new checklist (Hawksworth et al. 1980); the new card issued in 1984 lists 1.100 species, almost 75% of the known flora, and also incorporates selected lichenicolous fungi.

The collection of data on the mapping cards was a daunting task. With about 1600 species and 3850 squares (or part squares) progress could not have been made without the concerted efforts of numerous individuals. At any one time during the last two decades, about one fifth of the British and Irish membership of the Society have been regularly submitting records to the Scheme, with a peak of almost one quarter in the late 1970s (Seaward 1988). The regular publication in The Lichenologist of progress maps showing squares visited, and verbal presentations at Society meetings, encouraged members to visit unrecorded sites. Further, Society field meetings were deliberately held through the 1970s in areas which were short of records.

By 1989 cards had been received for 92% of the squares in England, Scotland and Wales, but for only 58% of those in Ireland; the adequate coverage of Ireland has been hampered by a shortage of fieldworkers resident in that country and a reluctance of many others to visit it. Overall coverage has continued to improve, and the current progress map (Fig. 1) bears testimony to a remarkable voluntary effort. It is also gratifying that the average number of species recorded from each square has continued to increase steadily, the proportion of squares with over 100 species recorded from them rising from less than 14% in 1973 to 40% in 1989 (Table 1). Nevertheless, this should not be any cause for complacency, as while 100 species may well be a realistic total for polluted and built-up regions, certain well-studied areas in rural unpolluted south-west and western regions are known to have around 400 species in a single 10 km square.

Fieldwork is only one aspect of the building up of data for inclusion in mapping schemes. In order to be comprehensive, both to add a historical dimension and to accurately reflect what is known, it is essential that literature sources and herbaria are

Table 1. Numbers of 10 km × 10 km squares for which cards have been received 1973–86.

	No. Species Recorded			No. Squares
	Over 100	50–100	Under 50	covered
1973	238	458	1022	1745
1975	429	682	1113	2229
1979	830	869	1285	2984
1982	902	858	1176	2986
1986	1126	888	1111	3125
1989	1288	881	1048	3217

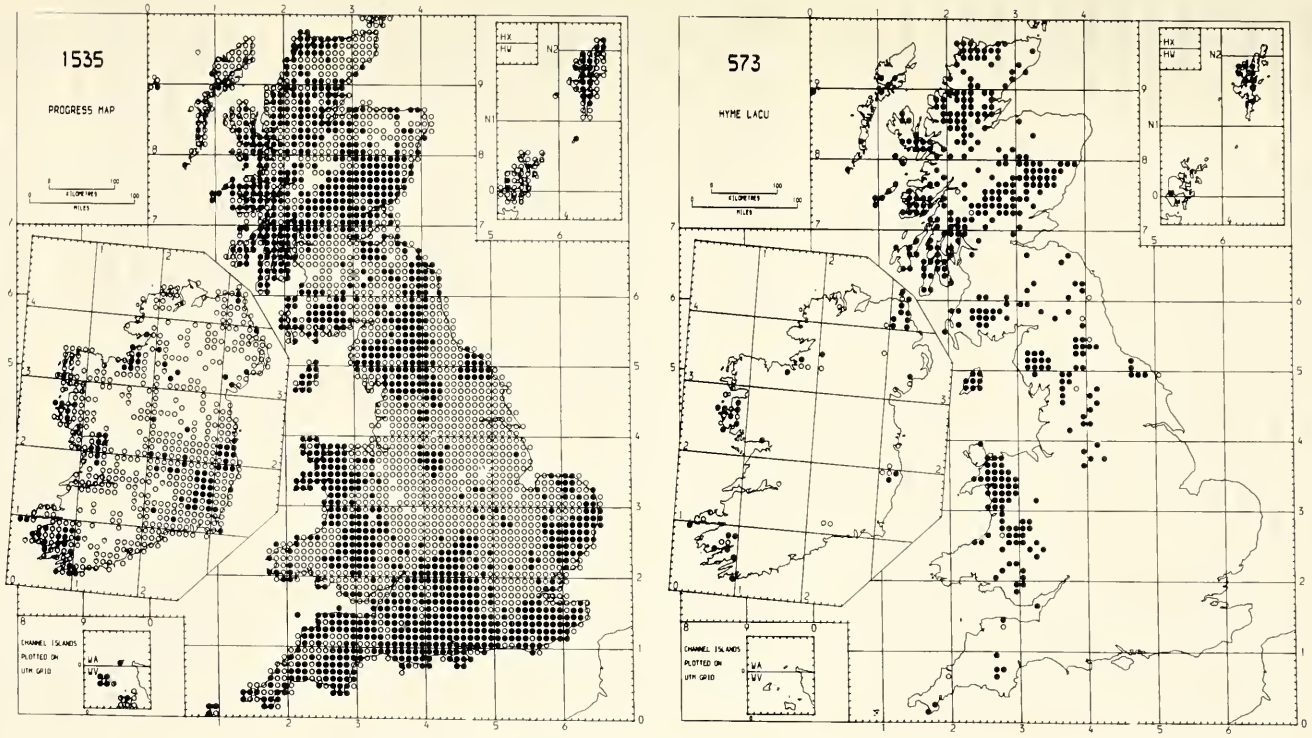

Fig. 1. (left) Progress Map (1989) for the British Lichen Society's Distribution Maps Scheme showing the number of species recorded per grid square (10 km × 10 km) since 1960. – *Dots* = 100 or more species, *circles* = less than 100 species.

Fig. 2. (right) Distribution map of *Hymenelia lacustris* Choisy in Great Britain and Ireland produced directly from computer output from the British Lichen Society's Distribution Maps Scheme Database. – *Circles* = pre-1960, *dots* = 1960 onwards.

also investigated. This is not only an extremely time-consuming task, especially as identifications often have to be verified and synonymies and misapplications of names unravelled, but also one which is less appealing to the amateur than fieldwork. The extent of this information has been assessed. MITCHELL (1971) provided a list of 422 publications including Irish records cross-indexed by vice-county, and HAWKSWORTH & SEAWARD (1977) one of some 2.700 publications relating to the rest of the British Isles, which were also cross-indexed; this last work also included information on the location of herbaria. In practice, these sources have only been used during the late stages of map production for selected species, or where local floras were being compiled. The number of publications relating to the British lichen flora continues unabated; it has been estimated that 870 titles were published during the period 1975–1985 alone (SEAWARD 1988).

In the first decade of the Scheme, the above data were also supplemented by individual species record cards which were suitable for punching and feeding via a card-sorter into the mechanical tabulator used for the initial maps (see above). These cards were mainly used by those producing systematic revisions and abstracting data from herbarium and literature sources.

3. Data storage

By the mid-1970s, it had become clear that the volume of data accumulated could no longer be dealt with satisfactorily by manual means. Mainframe computer facilities at the University of Bradford, a Control Data Cyber 180–830 Dual Processor Fortran 77 using access files and with some machine dependent aspects, was therefore employed. Computer input at that time was by punched cards, and as the original field mapping cards often proved difficult to read, large format transfer sheets had to be used. The programme could not accommodate old records, and checking of the punched cards via line-printer output was extremely laborious; furthermore minor mistakes in punching generated an overall error of 30%. This system was used to generate the raw data for the first atlas (SEAWARD & HITCH 1982).

While the University of Bradford mainframe system continues to store the British Lichen Society's expanding database, split into pre- and post-1960 records, manipulation since 1983 has been by a personal Tektronix 4107 linked to the mainframe. Updating is now on-screen and can be instantaneously validated and accessed either by species or location (i. e. grid reference).

4. Map production

The first maps to be produced by mechanical methods for publication were prepared mainly from individual record cards processed by the Monk's Wood tabulator for *Pseudevernia furfuracea* and its chemotypes (HAWKSWORTH & CHAPMAN 1971), and 14 *Alectoria* s. lat. species (HAWKSWORTH 1972). A series of maps for selected species was then initiated in The Lichenologist, which ran from 1973 to 1977. As Ireland has an independent national grid system, for the first maps grid references had to be converted to those of the base maps.

By 1975, sufficient data were available for the publication of an atlas to be contemplated, and in that year the Natural Environment Research Council (NERC) approved a grant to enable a post-doctoral research assistant to work full-time on the project. From 700 preliminary maps prepared from the Bradford computer database by line-printer, 250 were selected for possible inclusion in the first volume and circu-

lated amongst 20 specialists for additional records. This proved a lengthy process and it was not until 1980 that 176 maps for first publication were finally decided. Rubrics were then prepared by several of the specialists and spots added to base maps manually to produce camera-ready copy for the first volume (SEAWARD & HITCH 1982).

New computer technology has transformed production methods since that time. The Tektronix 4107 now used for data capture (see above), operating on Fortran 77 with GHOST 80 graphics library, enables screen-displayed maps to be converted into a variety of cartographic outputs via microcomputer- or mainframe linked printers. These include microfilm, microfiche, colour graphics, and maps of a quality for camera-ready printing (Fig. 2). Using these facilities, a provisional second volume of the atlas was produced in a mere three weeks from data retrieval to publication (SEAWARD 1985) compared with two years by the manual methods used for the first volume.

Maps can now be produced on demand. Although these have not been subjected to the scrutiny of specialists and do not include supplementary records from other sources as did those issued in 1982, these are a boon to research workers. During the last three years in particular, numerous maps have been prepared specifically for contributors to The Lichen Flora of Great Britain and Ireland (COPPINS et al. 1991).

5. Discussion

It is pertinent to emphasize first that the main impetus for data collection came after the production of a new checklist and a flora for the identification of the commoner species. We believe these were crucial factors in enlisting the essential support of amateurs.

During the first twenty-five years of its existence, the British Lichen Society's Mapping Scheme has seen a revolution in computer technology. If the Scheme were being initiated now, a much more comprehensive field structure for data capture would have been designed with the following main abilities: to sort by date category and substratum, and to retain integral site lists within the main database to enhance the value of the database for conservation purposes.

Further, the software to be used, and more importantly the data elements stored, should be compatible and similarily defined to those being used in other mapping schemes. In the UK alone, for example, there are already atlases available for 49 groups of organisms (HARDING 1985). On a European scale, a scheme is already in operation for vascular plants (COMMITTEE for Mapping the Flora of Europe 1967), and those on fungi as a whole are now starting to be coordinated by an international group established at the Tenth Congress of European Mycologists in 1989. The internationally recognized Taxonomic Databases Working Group for Plant Sciences is already well-advanced in establishing exchange formats for chorological and systematic data elements (e. g. BISBY et al. 1990). There is much to be gained by learning from and then working with those who have already followed almost identical paths. At a time when systematic expertise is scarce in many countries, we must be wary of too many of our number being transformed into narrow computer specialists.

With the technology now becoming available, there is a massive potential for databases with biological records to be used for environmental evaluation and determination of relationships with one or several factors by multivariate analysis. These abilities are particularly important in the light of increasing public concern for environmental and conservation issues. We should endeavour to place ourselves in a position

to answer queries and generate data when required by others. The recent "Red List"of endangered macrolichens in the countries of the European Economic Community (EEC) did not include maps (Sérusiaux 1989); for the next edition we hope national schemes will be linked to generate this key supporting evidence.

6. Acknowledgements

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7. Literature

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