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JOINT NATURE CONSERVATION COMMITTEE

THE STATE OF FIELD LICHENOLOGY IN SCOTLAND AND THE UK

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1. Background

- 1.1 In Scotland in 2001, there were four field lichenologists of repute available for site monitoring and other contract work relating to the identification and survey of lichens. As it happens, these were two couples: Brian and Sandy Coppins, based in the RBG(E), and Les and Sheila Street from Kingussie. Les Street was the northern reserves officer for the RSPB, but was available for limited contract work with his wife, who had 15 years of field experience in lichen surveying. However, in early 2002, Les Street accepted a new RSPB post in the Isle of Wight, and he and Sheila have indicated that they are no longer available for contract work in Scotland.
- 1.2 In February 2002, Stephen Ward, who has responsibility for 'lower plants' in Advisory Services of SNH, received a letter from Brian Coppins, indicating that he intended to withdraw as a main player from field work relating to the Biodiversity Action Plan, and to concentrate on taxonomic studies and curation of his collections from Borneo, Chile and Sweden. This serves to highlight the critical state of lichenology in the British Isles at present.
- 1.3 Overall, the BAP process has brought tremendous benefits to our knowledge of the distribution, autecology and conservation requirements of many lichens. This could be extended to the many other species (and their habitats) that are deserving of equal attention. Furthermore, the current round of work (i.e. preparation of species dossiers) is not the end of the story - actions are prescribed, and suitably trained and experienced personnel are required to carry out or supervise such work. The UK BAP (and related) work also needs to be taken more in to the international scene, with, for example, involvement in the objectives emanating from the Planta Europa 2001 conference. These amount to a full-time obligation, especially as the UK, in particular Scotland, is a biodiversity hotspot for lichens, and the high degree of 'international responsibility' needs to be recognized.
- 1.4 Brian Coppin's letter indicated also that his wife, Sandy is contracted to major field surveys in Somerset for EN and NT, initiated in 2000. In addition, she has cut back on her consultancy work to allow time for her duties as President of the British Lichen Society in 2002 and 2003. She, therefore, is not available for survey work in Scotland in the foreseeable future.
- 1.5 Stephen Ward, of SNH, has commented that he knows of no experienced consultants resident within Scotland and only two elsewhere in UK (Bryan Edwards & Vince Giavarini who both happen to be based in Dorset;

Vince has carried out work in Scotland as a subcontractor to the RBGE). The situation is little better with respect to fungi, where I know of just one field mycologist (Liz Holden), able to tender for SNH's requirements. Thankfully, the situation for field bryology is a little better with 3 or 4 consultants available to work in Scotland.

- 1.6 It is therefore difficult to see how SNH can meet its commitments for lichen survey and monitoring, as required for Site Condition Monitoring of SSSIs in which lichens and other lower plants are a significant interest. As noted in para 2.3, it is also unclear how some of the requirements flowing from the UKBAP for lichens and other lower plants can be addressed without suitably experienced experts able to take on work in the field. Although appropriate contractors may still be available in England and Wales, these are clearly few in number and limited in their overall capacity; any further loss of contractors could therefore lead to similar problems in the other country agencies. The situation for the fungi may also become critical in the near future.
- 1.7 Discussions with Mary Gibby, Head of Science at the RBGE and a member of SNH's Scientific Advisory Committee, confirmed that the RBGE recognised this issue to be part of what it called the '**taxonomic impediment**'. This was considered in evidence presented by the RBGE to the House of Lords Select Committee inquiry into Systematic Biology and Biodiversity. This states (para 6): "Within RBGE there are now serious gaps in expertise, most notably in fungi where replacement of our retired specialist Professor Watling has been postponed for a number of years to save costs." It goes on to state (para 25) "Additional grant in aid would allow RBGE to recruit taxonomists in strategic areas including fungi, cryptogamic plants and certain large and complex groups of higher plants." The RBGE evidence to the Select Committee is appended as Annex 1, but it is unlikely that RBGE is alone in facing staff shortages of this kind, and Committee members may be aware of losses of similar experts from other institutes.

2. Possible Ways Forward

- 2.1 This matter was considered at a regular liaison meeting between botanists in SNH Advisory Services (Chris Sydes and Stephen Ward) and Plantlife, as the leading plant conservation charity in the UK on 21st February 2002, and further considered at the Plantlife Link meeting in London on 14th March.
- 2.2 These meetings identified a number of short- and medium-term measures that might be considered to begin to address this 'taxonomic impediment'. As noted below, each of these has some benefits and some weaknesses:-
 - a. Trawl all research institutes and universities to identify whether their are lichenologists and other lower plant experts within these institutes who might be available to tender for research and survey work *[it seems relatively unlikely that many such individuals exist, and, if they do, they may be fully occupied on other commitments within their institutes]*;

- b. 'Import' lichenologists from the Continent, since countries like Denmark still produce specialists in these fields who might well appreciate the opportunity to study lichens in Scotland [*this is likely to be a more expensive option, in view of travel costs, and the relevance of their experience to Scotland and the UK may be somewhat limited*];
- c. Prepare practical business guidance advice to encourage amateur lichenologists to step across the divide into freelance contract work, recognising that there is significant demand for such contract appointments [*it is not immediately clear whether there are suitable skilled amateurs available, and it is unlikely that many of these will be tempted to take the financial risk of an uncertain future as a freelance*];
- d. Grant-aid a studentship in lichenology at a suitable university or research institute [*this would be, at best, a medium-term solution, and there is always a risk in investing in one individual who could not be guaranteed to take on field work at the end of the studentship*];
- e. Grant-aid a course in lower plants at one or more universities and/or research institutes, to encourage more students to consider studying cryptogams [*this would also be, at best, a medium-term solution, and there would be no guarantee that practical field ecologists would emerge at the end of the course*];
- f. Grant-aid a 'champion' for lichens, through the British Lichen Society or Plantlife, perhaps based at one of the botanic gardens or other appropriate institutes, to promote the study of lichens, and the career opportunities they may present, through lectures and other available academic channels [*potentially less expensive than options (d) or (e), but, at best, likely to have a medium-term impact and with no guaranteed outcomes*].

2.3 Committee is invited to consider the options above and offer their views on their likely effectiveness, and to suggest whether any other solutions can be identified. Committee is also asked to consider whether and how any of these options could or should be taken forward.

SYSTEMATIC BIOLOGY AND BIODIVERSITY

Evidence from The Royal Botanic Garden Edinburgh (RBGE)

Background

1. Systematic biology generates and organises our knowledge about the diversity of life on Earth by tackling three major challenges:
 - 1a. *Discovering, documenting and describing biodiversity* so that we can identify, manage, use and conserve it.
 - 1b. *Elucidating the evolutionary history of life*, through phylogenetic analysis, which leads to predictive classifications for efficient retrieval of information.
 - 1c. *Making this knowledge available* to many user communities.
2. Systematics is therefore a fundamental and strategically important science that provides the foundation for all practical uses and applications of biodiversity and for understanding the complex web of life of which we ourselves are a part.
3. Systematics involves the comparison of biological specimens and is centred around living and preserved collections of biodiversity found in natural history museums, botanical gardens, culture collections and some other institutions. Historically, the UK is disproportionately rich in such collections. With more than 104 million specimens, of which at least 10% are type specimens the UK holds a global resource of immense importance. The majority of the UK's effort in systematic biology is concentrated in three major institutions: the Royal Botanic Gardens of Kew and Edinburgh and the Natural History Museum (NHM).
4. Since the 1980's several factors should have led to increased investment in systematic biology, but have not yet, including:
 - i. Growing awareness of the importance of, and threats to, biodiversity has led to the Convention on Biological Diversity (CBD) which has emphasised the importance of knowledge about species, the components of biodiversity. Taxonomy is now recognised as the rate limiting process in implementing the CBD, and this has been termed the "taxonomic impediment".
 - ii. It is now appreciated that the global inventory of species is far from complete. 1.7 million species have been described out of an estimated 13 million. Previously the total was put at 3 million and the task considered almost complete.
 - iii. Rigorous and repeatable methods of phylogenetic analysis have replaced previous classification procedures based on consensus or authoritarianism.
 - iv. The comparison of DNA sequences, in addition to traditional data, has accelerated the rate of phylogenetic analysis and led to repeatability and greater harmonisation of methods which enabled large international efforts such as the *Angiosperm Phylogeny Project (AGP)* for flowering plants.
 - v. The Web now provides an ideal medium for the knowledge-based science of systematics and major infrastructure projects, such as the Global Biodiversity

Facility (GBIF) and the National Biodiversity Network (NBN) are under way. However, the mobilisation of information from biological collections remains a significant and expensive task.

RBGE's Contribution to Systematic Biology and Biodiversity

5. RBGE's mission is to explore and explain the world of plants. Founded in 1670 and taking its remit from the National Heritage (Scotland) Act of 1985, it is a Non-Departmental Public Body sponsored by the Scottish Executive: Rural Affairs Department (SEERAD).
6. RBGE is the UK's third largest systematic biology institute. It has a global herbarium of more than 2 million specimens of fungi, algae and all groups of land plants. Its four gardens house the second richest living collection of plant species (15,500) in the World with good representation of groups (such as Ericaceae, Gesneriaceae, Umbelliferae and conifers) and geographical regions (including the Sino-Himalaya, Australasia, and temperate South America) that link to long term research interests. RBGE has the most important botanical library and archive in Scotland. Laboratory facilities support optical and electron microscopy, molecular biology and a variety of other procedures. The staff number 207 (8 in the Directorate and Development, 48 in Science, 86 in Horticulture, 14 in Public Programmes and 47 in Corporate Services), plus 12 externally funded staff, 30 research associates, a student population of about 40 and a substantial number of volunteers. With the decline in university based systematists, RBGE accepts that it should play a greater role in teaching, research and conservation but sees little scope for expanding its contribution. Within RBGE there are now serious gaps in expertise, most notably in fungi where replacement of our retired specialist Professor Watling has been postponed for a number of years to save costs.
7. RBGE's programme of plant systematics results in inventories, floras, identification aids, monographs, revisions, conservation genetic studies and phylogenetic and biogeographic analyses with projects in 40 countries around the world. It contributes to conservation at a policy level, through the provision of expertise and information, and in practice through *ex situ* and *in situ* projects (especially in Scotland and China). RBGE is active in initiatives of the CBD including the Global Taxonomy Initiative (GTI), Global Plant Conservation Strategy (GPCS) and the UK delegation to the CBD. It is lead partner for 11 Species Action Plans and has produced "species reports" for Scottish Natural Heritage (SNH) on all 40 of Scotland's Biodiversity Action Plan lichens.
8. Extensive educational programmes for schools, teachers and the general public are provided by RBGE. It trains future generations of taxonomists through a joint MSc on *Plant Taxonomy and Biodiversity* with the University of Edinburgh, based at the Garden and supported by five studentships from NERC. It also teaches an HND in Horticulture with Plantsmanship, with the Scottish Agricultural College (SAC).
9. RBGE has many collaborative links within the UK and elsewhere. Three-way meetings, held at least once a year since the 1960's, continue to ensure effective coordination with RBG Kew and the NHM making best use of complementary resources either by working together or by avoiding duplication of effort, as appropriate. This process provides comparative information for benchmarking, for example, in the recent RBG Kew Science Audit.

10. As the National Botanic Gardens of Scotland, the four gardens provide much valued public amenity as one of Scotland's top visitor attractions for over 700,000 people per annum. In Edinburgh it is second only to the Castle in visitor numbers.

Funding of RBGE

11. RBGE is primarily (about 85%) funded by grant-in-aid from SEERAD. In 2001/02 grant-in-aid was £6,182,000 made up of £667,000 for capital and £5,515,000 recurrent funds (an initial allocation of £4,990,000, plus additional grant of £450,000 and £75,000 towards early retirements). Annex 2 shows that the proportion of expenditure on systematics has scarcely changed, despite the necessity of increasing other activities in the Corporate Services Division. The diverse functions required by the National Heritage (Scotland) Act of 1985 allow little scope for increasing systematic effort at the expense of other activities.
12. In 1992 the grant in aid to RBGE was £5,597,000 (comprising £4,504,000 recurrent and £1,092,000 capital). If core funding since 1992 had been maintained in real terms as recommended in the Dainton Report, in 2001/02 it would have totalled £7,728,000 (£6,800,000 recurrent, capital funds about £928,000) based on the Government "deflator" (equivalent to the retail price index). Thus, at RBGE grant in aid has fallen below 1992 levels in real terms by around £1,500,000. Comparison of grant-in-aid figures for RBG Kew and the NHM shows an almost identical pattern of decline in funding against 1992 values.
13. During the last decade funding has been problematic with RBGE making strenuous efforts to improve efficiency against a background of declining resources, in real terms. However, the Garden's recently introduced financial strategy is to grow its overall resource base by increasing self-generated income whilst seeking additional grant-in-aid to invest in this "plan for success". This financial strategy has been supported by SEERAD which in 2001/02 has awarded additional grant-in-aid totaling £930,000 over the next three years (£450,000 during 2001/02 referred to in paragraph 11, £150,000 in 2002/03 and £330,000 in 2003/04; plus a transfer from the capital allocation to recurrent of £150,000 in 2002/03). Furthermore, SEERAD has agreed to consider a submission to the Public Spending Review in 2002 which will set out the specific outcomes that would be delivered by RBGE if further grant-in-aid resources were made available.

Changes in UK systematics since 1992

14. There have been both positive and negative developments in UK systematics since the 1992 Dainton Review including those listed below.
15. The (CBD) has led to increased emphasis on biodiversity in government policy at national local and European levels. From the standpoint of a biodiversity and systematics institute such as RBGE, this has to be seen as a positive development although it has, to date, mainly added to our workload, for example, in implementing Species Action Plans, or contributing to CBD initiatives, without bringing equivalent new resources.
16. The Darwin Initiative, itself a response to the CBD, has successfully supported international partnerships to achieve specific outcomes. Many projects have had a taxonomic component and RBGE has led 7 Darwin Initiative projects with a total value of £766,000. However, the Darwin Initiative does not cover over-head costs and so acceptance of these projects placed a burden on the institutional budget.

17. Molecular techniques have been assimilated into the normal working practices of RBGE, especially for phylogenetic systematics and conservation genetics. This has led to significant progress on one of the three challenges of systematics: understanding the "Tree of Life" (paragraph 1b). However, it has required considerable capital investment in DNA sequencing and related facilities and the recruitment of specialist support staff. Given that these new developments in systematic biology were accommodated against a background of declining resources they have inevitably reduced the Garden's contribution to discovering, documenting and describing plant biodiversity (alpha-taxonomy, paragraph 1a).
18. There have been significant advances in bioinformatics since 1992. These include the emergence of the Global Biodiversity Information Facility (GBIF) and other initiatives which provide an infrastructure for biodiversity information and advances in database design and automated identification. RBGE has developed research in automated identification of diatoms (using computerised identification to overcome the taxonomic impediment) and taxonomic databases with three awards from the BBSRC/EPSRC Bioinformatics Initiative to principal investigators at the Garden. This strategically important research is endangered because these scientists are ineligible to apply for further awards now that bioinformatics is to be funded in responsive mode (see also paragraph 28). For the future, the world wide web should be the medium of choice for disseminating information to the end users of systematic biology. However, a major but once-only cost will be the conversion of collections information into computerised form. A high priority though this is, as a means of overcoming the taxonomic impediment, the significant financial resources required are not at hand.
19. The Dainton Report itself led to a review by NERC (the Krebs Report) and the NERC Taxonomy Initiative with its lasting legacy at the three universities involved. However, in most other universities, except the University of Oxford, plant taxonomy is scarcely present as an academic discipline.
20. The Dainton Report established the UK Systematics Forum, with funding from OST from 1993 to 1996. A database of UK expertise was created but, although replicated in other countries, has not been maintained in the UK. In 1998 the Forum published a National Strategy for Systematic Biology (*The Web of Life*) developed through a process of discussion and consensus building. When the resources needed to implement this strategy were not forthcoming the Forum lost impetus.
21. Internationally, the Dainton Report prompted the European Science Foundation to launch a European Systematic Biology Network which had two important outcomes: the establishment of the Consortium of European Taxonomic Facilities (CETAF) and an analysis of the resources for systematic biology at the European level (Blackmore, S. and Cutler, D. (Eds). 1996. *Systematics Agenda 2000, the Challenge for Europe*. Linnean Society Occasional Publication - Number 1. Samara Press, Tresaith). The outcome of these various networks is that there is much better coordination and communication amongst systematists within Europe and internationally. The Framework programmes of the EU have recognised a number of natural history museums as Large Scale Facilities.
22. Set against these positive changes has been the failure to implement the principal recommendation of the Dainton Report, for maintenance of core funding at the major institutions (Recommendations 9.7, 9.10 and 9.11), with the consequence that funding for systematic biology has continued to decline. A situation that was deemed a cause

for concern in 1992 is now substantially worse. This is a matter of grave concern to RBGE's Board of Trustees.

Changes required to enable the UK to meet its policy aims on biodiversity

23. The steps needed to remedy the poor situation in systematic biology and enable the UK to meet its policy aims on biodiversity can readily be identified. Indeed, they were readily apparent to the 1992 Select Committee review. What needs to happen can be described under the general heading of removing the taxonomic impediment. This problem, identified through the processes of the CBD applies as much within the UK as it does to the UK's wider global contribution.
24. That the Dainton Report failed to achieve its intended outcomes reflects a failure among science funding agencies, whether government departments or research councils, to recognise that systematic biology is a strategically important area of fundamental science in which the maintenance and development of the UK's national capacity is a matter of long term economic importance. This suggests that the importance of biodiversity has yet to be appreciated, despite the ten years that have passed since the Rio Summit. Alternatively, it may be that although the importance of biodiversity is understood, the pivotal role of systematic biology in relation to biodiversity is not. It will be difficult to access genetic raw materials for biotechnology if we cannot distinguish organisms or understand how they are related in terms of shared evolutionary history, shared DNA or shared properties. It will be difficult, if not impossible, to identify alien invasive species at an early stage without a national resource of expertise across all major taxa. Although birds and other important bioindicators will reveal some important patterns of environmental change, ignorance of other changes in the UK's biota is not bliss. Those who have sought to advance the importance of systematic biology have often been accused of special pleading. However, it is difficult to identify an area of science of such relevance to the quality of life in the future.
25. The most direct means of addressing the taxonomic impediment and enabling the UK to meet its policy aims on biodiversity is to increase the grant-in-aid to the UK's key players. Recognising that the UK's three largest systematic biology institutions probably deliver more than 90% of UK's output in systematics, their grant-in-aid needs to be increased to take account of the policy level importance of this role. SEERAD has recently provided additional funds to RBGE although not to an extent that would restore core funding to 1992 levels. Given the many demands upon Sponsor Departments they are unlikely to be able to direct further resources towards prioritising systematic biology, unless their overall resources are increased. Thus it should not be left to Departments to address from within their existing budgets, but needs to be addressed centrally. On the basis of the comparisons set out in paragraphs 12 and 13, the total additional cost of restoring the grant-in-aid of the Royal Botanic Gardens of Kew and Edinburgh and the NHM to 1992 levels is about £14,000,000. Additional grant in aid would allow RBGE to recruit taxonomists in strategic areas including fungi, cryptogamic plants and certain large and complex groups of higher plants. Although for certain taxa there would be a need to train people to PhD level, there is also, sadly, already a pool of well-qualified and highly experienced plant taxonomists unable to find work.
26. A secondary mechanism would be to target a proportion of the UK spend on biodiversity to the major systematic biology institutions in order to deliver particular

outcomes. The UK contributes substantial sums to the Global Environment Facility (GEF) to deliver outcomes such as the GTI with few visible results. It would make better use of scarce resources to commission systematic biology institutes to deliver the desired outcomes through bilateral or regional projects. ODA, and DfID, effectively did this in the past, supporting work at RBGE on the Flora of Bhutan and the Cerrado of Brazil. The UK aid programme has lost sight of the relationship between human well being and the state of their environment. Taxonomic inventories, such as the Flora of Bhutan, now completed after 27 years with Danish aid funding replacing UK funds, provide the knowledge base for natural resource management.

27. Since 1992, the one new mechanism that has promoted links concerning biodiversity between UK institutions and developing countries has been the Darwin Initiative. Providing that the financial difficulties of systematic biology institutions have been addressed, a further supporting action would be to address the finances of the Darwin Initiative. The budget for the Initiative could be increased to allow a small proportion of its projects to be more substantial and directed towards specific issues, such as the taxonomic impediment. Project funding should be revised to include a contribution towards the overheads of contributing institutions. Given the difficult funding situation in institutions, it is not appropriate to regard the contribution they necessarily put into projects as “additional funds leveraged” by the Darwin Initiative.
28. A number of changes within Research Councils could make a significant difference. There should be a level playing field so that researchers in all institutions (not just the NHM) can apply for grants. RBGE is accepted as a research analogue by NERC but rejected by BBSRC on the grounds that it is “primarily funded for research purposes by another funding body”. This recent decision will be contested by RBGE noting, amongst other things, that universities are institutions primarily funded by HEFCE. A research council panel should be established to address the areas of biological inventory (essentially, alpha taxonomy) and the training of taxonomists in selected groups where expertise is lacking or endangered. The latter could be modelled on NSF’s Partnerships for Enhancing Expertise in Taxonomy (PEET) Initiative.
29. RBGE is grateful to the Committee for investing their time and energy in the review and looks forward to a successful outcome. Above all we hope that a further review in ten years time will not be necessary.