

BIOSCIENCES FEDERATION



INSTITUTE
OF BIOLOGY



British Ecological Society

Systematics and Taxonomy Response to the House of Lords Science and Technology Committee

4 February 2008

Summary

1. Systematics and taxonomy are enabling sciences that are fundamental in answering policy and research questions for the major scientific and social challenges of this century: preserving biodiversity, maintaining ecosystem services and adapting to climate change.
2. They underpin many other areas of bioscience, support economically important activities, and enable the UK to comply with its legal and moral obligations to protect the environment and its natural resources.
3. The UK has international centres of excellence for systematics and taxonomy, and collections of international and national importance. It also benefits from active groups of amateurs, some of whom carry out and publish research of the highest quality.
4. Systematics and taxonomy research in universities is disadvantaged by the Research Assessment Exercise (RAE), to the detriment of research and training.
5. Too little of the skills base is now held by professionals. Amateurs continue to play an essential and valued role, and require a properly funded infrastructure.
6. Current funding and policy mechanisms are not well co-ordinated and fail to take account of the particular needs of this area of enquiry.

Recommendations

1. A periodic (five-yearly) survey of the state of systematics and taxonomy research, education and skills base in the UK.
2. The Research Excellence Framework must include measures of excellence relevant to nationally important areas of research, including systematics and taxonomy.
3. Strategic longer-term funding mechanisms to support research and the necessary infrastructure including taxonomic collections, libraries and long term monitoring.
4. Funding mechanisms for outputs that are fundamental to taxonomy, such as writing monographs and identification keys.
5. The Environment Research Funders Forum should be specifically funded to monitor and co-ordinate taxonomy and systematics research and training, working with users, employers, the systematics community and other interest groups.
6. The Government Office for Science should use its co-ordinating role to ensure that government departments work together, identify their policy and research needs and fund the necessary research and infrastructure.
7. The Department for Environment, Food and Rural Affairs (Defra) must recognise the strategic role of taxonomy and systematics in delivering key policy objectives.
8. The Department for Culture Media and Sport (DCMS) should appoint a chief scientist to ensure that it has the best advice on the museums and collections of scientific value which it supports.
9. A major funding initiative to improve the quality, compatibility and usability of molecular taxonomic databases.
10. It should be a condition of publication of taxonomic research for the data to be deposited in a web-based database.
11. Funding for specialist courses and training fellowships in strategic subjects where there is an identified skills gap.

About the Biosciences Federation, British Ecological Society and Institute of Biology

The **Biosciences Federation** (BSF) is a single authority representing the UK's biological expertise, providing independent opinion to inform public policy and promoting the advancement of the biosciences. The Federation brings together the strengths of 44 member organisations (plus seven associate members), including the Institute of Biology and British Ecological Society.

The **British Ecological Society** is the learned society for ecology in the UK. Founded in 1913 and with over 4,000 members, the British Ecological Society supports ecologists and promotes ecology, the study of living things and their relationship with the environment in which they live. The Society's mission is to advance ecology and make it count.

The **Institute of Biology** (IOB) is an independent and charitable body chartered by Royal Charter to further the study and application of the UK's biology and allied biosciences. IOB has 14,000 individual members and many specialist learned Affiliated Societies.

Together, BSF and IOB represent a cumulative membership of over 65,000 individuals, covering the full spectrum of biosciences from physiology and neuroscience, biochemistry and microbiology, to ecology, taxonomy and environmental science.

Definitions

In this submission, we define the terms as follows:

Systematics is an activity in the biological sphere which takes a comparative approach.

Taxonomy is a subset of systematics, involving the description, identification and naming of organisms.

The state of systematics and taxonomy research

Q1. (a) *What is the state of systematics research and taxonomy in the UK?*

A1a. Tackling climate change, conserving biodiversity, and maintaining the ecosystem services (on which we all depend for our health, wealth and wellbeing) are the major scientific and social challenges of this century. It is increasingly apparent that they are interconnected, and that solutions for one area can bring substantial benefits to another. **Systematics and taxonomy research are fundamental in answering policy and research questions that are relevant to these issues.**

We are not aware of a comprehensive survey of the state of systematics research since the UK Systematics Forum survey 11 years ago. The Forum published a strategy and identified research priorities¹. The Natural History Museum's taxonomic needs assessment² in 2006 identified and prioritised areas where taxonomic information is needed for biodiversity conservation in the UK and its overseas territories, but did not identify which of these needs resulted from a lack of taxonomic expertise rather than failure to disseminate information. The UK Biodiversity Research Advisory Group has identified an extensive list of biodiversity research needs³, but with surprisingly little reference to taxonomy and systematics research. These strategies and surveys seem disappointingly uncoordinated.

The UK has international centres of excellence for systematics and taxonomy, and collections of international and national importance. It also benefits from active groups of amateurs, some of whom carry out and publish research of the highest quality.

Experts in systematics and taxonomy tend now to be employed in museums and botanic gardens rather than universities, and we understand that there is a big decline in specialist taxonomists in these institutions too.

Much of the skills base in taxonomy is now held by amateurs, who do much valuable work. Many of them are over retirement age. Local recorders are often in their sixties, and few new ones are coming through to replace them. For example, the recorders group of Hertfordshire Natural History Society has 25 recorders (a large group for a county). Two of these individuals are under 35, four in their 40s, ten in their late 50s, six over 60 and three in their 70s.

In bacterial systematics, the output of the UK – measured by the number of papers per year describing new bacterial species or other taxa – has fallen from over 25 in 2000, to less than ten in

¹ The web of life: a strategy for systematic biology in the United Kingdom

http://www.nhm.ac.uk/hosted_sites/uksf/web_of_life/index.htm

² United Kingdom taxonomic needs assessment (2006) Natural History Museum/Defra

³ Research needs for UK biodiversity (2007) UK BRAG/Defra

http://www.jncc.gov.uk/pdf/BRAG_REPORT_2003-2006.pdf

2007. This is largely due to the winding up of two very active and internationally recognised research groups in UK universities. Only one of these was due to retirement of the principal investigator.

Does it matter that taxonomy and systematics research is leaving universities? We believe it does. Any systematist at a university nearly always has a main research interest in another area. The leading systematic institutions make an excellent contribution and universities can and do look to them for expertise, co-supervision of research students, teaching on MSc courses and sometimes teaching undergraduates. But these are always as adjuncts and it makes a difference, for example in reduced interaction with students, that they are not in the universities themselves.

Data from the *International Journal of Systematic and Evolutionary Microbiology* (published by the Society for General Microbiology) illustrates the decline in UK-based research to describe new species of bacteria. UK papers comprised 8-10% of papers in this journal in 2000-01. Now, only 2% of the papers are from the UK, and almost none of the overseas papers has a UK co-author. In comparison, following a large injection of funding from the South Korean Government, the number of papers from Korea has increased 12-fold in the past five years. A similar decline in UK-authored papers is seen for articles in the *Lichenologist*⁴.

We recommend a periodic (five-yearly) survey of the state of systematics and taxonomy research, education and skills in the UK. This might usefully be carried out by the Environment Research Funders Forum as part of its planned review of skills needs and training priorities in the environmental science sector for the next ten years (see Q12). Such a review must be co-ordinated with related reviews, for example of biodiversity, climate change impacts and ecosystem services research. We call on the systematics community to actively support a review and provide data and evidence to it.

Q1b. *What are the current research priorities?*

A1b. It is not realistic to attempt to describe as many species as possible across all phyla before they become extinct – resources would be stretched too thinly and the project would take hundreds of years. Given the huge gaps in our knowledge of species from most phyla, **priorities need to be driven by research and policy questions.**

For example, when searching for new antibiotics we know from earlier taxonomic research that most current antibiotics come from small subgroups of species of actinomycete bacteria – so these subgroups would be a priority for future investigations for new drugs. If asking questions about the impacts of climate change, it might also be important to fill gaps in our knowledge of known groups. Diatoms are very useful in studying ocean currents and the effects of ocean acidification, so further research on this group is likely to be fruitful for improving our understanding of ocean change in a changing climate.

Q1c. *What are the barriers, if any, to delivering these priorities?*

A1c. The main barriers are a lack of a new generation of taxonomists to replace those that will soon retire, funding, and the tyranny of the Research Assessment Exercise (RAE). Universities are reluctant to appoint taxonomists to permanent posts since the value of this work is not recognised

⁴ Submission to this inquiry by the British Lichen Society.

by RAE criteria: they don't bring in large grants or publish in high impact journals. Young researchers turn to areas which give them better long-term prospects. Those staff that do remain in universities are mainly over 50.

Training and education in systematics and taxonomy is a major problem because of the paucity of university systematists. Most of the country's conservation biology courses at undergraduate or MSc level, for example would benefit from more teaching in these areas. For a more detailed discussion of training and education issues and barriers, see Q13.

Funding is also a barrier. Taxonomy falls into a gap between research councils' funding. A project proposal needs to be predominantly non-taxonomic, with a small taxonomy element, to succeed. It is rarely possible to get funding to write a monograph on a new species or to produce a species key – both these outputs are fundamental to progress in taxonomy, and are necessary preludes to answering the policy-relevant questions that taxonomy can address. But because they are relatively cheap but lengthy projects (mainly requiring staff time), they are hard to get funded via existing mechanisms.

Many freshwater invertebrate identification keys, for example, are over 50 years old and badly in need of updating. Compliance with the Water Framework Directive requires assessing the ecological status of surface waters. One might reasonably expect that such assessments would benefit from up-to-date keys.

Specific funding for taxonomy initiatives in the past have been welcome, but short lived. Most current research that gets funding is at the molecular level, which is important for the theoretical/evolutionary approach but not sufficient if looking to identify an organism in the field.

In a SWOT analysis⁵ the Environment Research Funders' Forum identified concerns over the funding, maintenance and accessibility of long-term data sets, the ageing academic research population in general and in environmental science in particular, the lack of integration across the research councils and the continuing difficulty of securing funding for cross-disciplinary research. While this analysis does not focus on taxonomy and systematics specifically, these concerns chime with our experience in these areas.

The funding infrastructure has not yet fully recognised the need to support strategic culture and other taxonomic collections and datasets, long-term monitoring programmes and libraries. Climate change has demonstrated the enormous value of these resources in answering questions that are now vital to understanding, monitoring and tackling the effects of global change. For example, the (poorly named) Continuous Plankton Recorder Survey in the North Atlantic and North Sea was discontinued for a period during which important changes happened in the plankton⁶. It was not recognised by funders at the time that continuous records of plankton would be so important today in answering important policy questions about changing climate, ocean currents and fisheries.

Culture collections are a vital component of the endeavours of taxonomy and systematics, and are constantly threatened by erratic funding. Consistent and long term core funding is needed for these national treasures, agreed via a peer review process. Too much emphasis is given in expecting culture collections to survive as commercial services, when they also have a national and

⁵ <http://www.erff.org.uk/documents/Finalversion.pdf>

⁶ Dickson, R., Colbrook, J.M. and Svendsen, E. (1992). "Recent changes in the summer plankton of the North Sea." ICBS Marine Science Symposia 195: 232-242.

international value for policy and research.

For museum collections, an active taxonomist curator attracts visitors to use the collections as they can give advice and information on the spot. Fewer taxonomist staff means the collections are not maintained, not updated, become less attractive to enquirers and less relevant to modern needs, eg comparing identifications and training.

Academic libraries, even in world class institutions such as the Natural History Museum, cannot afford to take all the relevant journals and are therefore no longer comprehensive reference libraries. Much published material of relevance to this community is not yet available electronically, and even where it is available may not be affordable to the community of amateur taxonomists upon whom the system relies.

Open Access publishing will help amateurs to read the academic literature but may be a barrier to publishing if they are expected to pay to publish in open access journals and their work is not funded by a grant. 40% of papers in the International Journal of Systematic and Evolutionary Microbiology do not acknowledge grant funding, so we assume that this research is not funded by grants. The Society for General Microbiology is currently funding the digitisation of the entire archive of the International Journal of Systematic and Evolutionary Microbiology, and will make this freely available online as part of its charitable mission to disseminate knowledge.

The Living With Environmental Change (LWEC) initiative provides an opportunity for properly co-ordinated funding, focussed around an important research question. The major funders are making available £1 billion of funding from 2008-2011. **We urge the taxonomy and systematics community to be proactive in helping LWEC develop into a sustainable funding model that can persist beyond the end of the initiative.**

We recommend:

- That the Research Excellence Framework must include measures of excellence relevant to nationally important areas of research, including systematics and taxonomy.
- Strategic longer-term funding mechanisms, to support research and the necessary infrastructure including taxonomic collections, libraries and long term monitoring. A proportion of government and research council funding for climate change and biodiversity initiatives could be earmarked for taxonomy and systematics research and training that underpin such projects.
- Funding mechanisms for outputs that are fundamental to taxonomy, such as writing monographs and identification keys.

Q2. What is the role of systematics and taxonomy and, in particular, in what way do they contribute to research areas such as biodiversity conservation, ecosystem services and climate change? How important is this contribution and how is it recognised in the funding process? How is systematics integrated in other areas of research?

A2. Systematics and taxonomy are enabling sciences that are fundamental in answering the policy and research questions in conservation, ecosystem services and climate change. They also underpin many other areas of bioscience and support economically important activities including agriculture, fisheries, horticulture, bioprospecting, medicine and veterinary science.

They enable the UK to fulfil its legal and moral obligations, for example in the UN Convention on Biological Diversity, EU Habitats Directive, EU Water Framework Directive, CITES and the Ramsar Convention.

They allow government bodies including Defra, the Department of Health, Ministry of Defence, Home Office and their agencies to monitor progress in meeting our national biodiversity targets, identify invasive alien species, identify and monitor new and emerging diseases of people, crops and livestock, and prepare for and respond to bioterrorist attacks.

This strategic contribution of systematics and taxonomy to our economy, health, well-being, security and ability to diagnose environmental problems is not currently recognised by the funding system. Fundamental university-based research in this area is disadvantaged by the Research Assessment Exercise, as described in the answers to Q1. Grant applications fall between the gaps of research council remits. Several government departments are responsible for overseeing and funding the main institutions and centres where taxonomy and systematics are carried out, and are responsible for policy areas for which taxonomy and systematics provide the evidence base.

Taxonomic skills and data are essential for any conservation or biodiversity project. Biodiversity Action Plans (BAPs) are incomplete because only well studied species are included. For example, the national BAP mentions only three freshwater invertebrates: the southern damselfly, freshwater pearl mussel and the native crayfish. Yet, in the specialism of a member of our working group, we know that the Trichoptera (caddis fly family) have at least seven listed as Red Data Book 1 (ie critically endangered) species, one of which is almost certainly extinct. This group is not mentioned in any BAP. The threats to many species may be underestimated if few people can identify and record them.

Q3. Does the way in which systematics research is organised and co-ordinated best meet the needs of the user community? What progress has been made in setting up a body to lead on this? What contribution do the leading systematics research institutions make both nationally and internationally?

A3. We believe that more progress should have been made in bringing together the main partners with an interest in this area: government departments, research councils, museums, learned societies and others. The Systematics Initiative was too narrowly focussed – a wider focus around climate change issues might be more fruitful. There has been little leadership from government departments and the professional and learned societies (including ourselves) in addressing this problem. We think that there is a role for the Environment Research Funders Forum here, since it already comprises all the main funders of taxonomy and systematics research and institutions.

When IOB asked Defra in 2006 for an update on progress in taking forward actions stemming from the 2002 House of Lords *What on Earth?* report, Defra told us: “I am afraid that as a result of the tight financial situation in Defra, prioritisation of our objectives and strategic outcomes has resulted in progress in systematics falling below the threshold to command the necessary resources”.

We are concerned that the Department for Culture, Media and Sport (DCMS) has failed to appoint a chief scientist, despite having accepted in 2005 the clear advice of the Government’s own

review⁷. DCMS funds the Natural History Museum and has policy responsibility for the museum sector that is so important for taxonomy and systematics in the UK.

We recommend:

- The Environment Research Funders Forum should be funded to monitor and co-ordinate taxonomy and systematics research and training, working with users, employers and other interest groups.
- The Government Office for Science should use its co-ordinating role to ensure that the government departments (including Defra, DCMS, DIUS, DH and the devolved administrations) work together, identify their policy and research needs and fund the necessary research and infrastructure.
- Defra must recognise the strategic role of taxonomy and systematics in delivering key policy objectives.
- DCMS should appoint a chief scientist to ensure it has the best advice on supporting museums and collections of scientific value

Q4. What level of funding would be needed to meet the need for taxonomic information now and in the future? Who should be providing this funding?

A4. The survey of the state of systematics and taxonomy research, education and skills base in the UK (which we recommend under Q1a) should address the first of these questions.

Given the numerous government departments, agencies and non-departmental public bodies who fund taxonomy and systematics research, it has not proved possible to discover how much funding is currently provided, nor how much might be needed.

We welcome the efforts of the Environment Research Funders' Forum (ERFF) to bring some clarity and co-ordination to environmental science funding, and encourage them to build on their portfolio of reports⁸.

Defra publishes public sector and NGO expenditure on biodiversity as one of its biodiversity indicators⁹, but strangely this does not appear to include research council expenditure. These figures suggest that expenditure is increasing, but over 90% of Defra's spend is on countryside stewardship schemes, and research spend is flat¹⁰.

NERC provides information on its grants and studentships in systematics and taxonomy¹¹. PhD studentship figures seem to show a dramatic decline over the past three years: 17 started in 2005, ten in 2006 and three in 2007. There is no clear trend in grant funding over the past ten years, and large variations from year to year in the number and total value of grants awarded for this area. Peak years were 1999 and 2004 (32 grants worth 1,290k in total and 30 grants worth a total of £1,170k respectively), with 1998 and 2005 having the lowest awards (15 grants, £337k and 14 grants, £311k respectively).

⁷ http://www.culture.gov.uk/Reference_library/Publications/archive_2005/response_to_ost.htm

⁸ <http://www.erff.org.uk/reports>

⁹ <http://www.defra.gov.uk/news/latest/2007/biodiversity-0612.htm>

¹⁰ http://www.jncc.gov.uk/pdf/Report_on_indicators_of_spending_on_biodiversity.pdf

¹¹ <http://www.nerc.ac.uk/research/gotw.asp>

The ERFF *Strategic analysis of UK environmental monitoring*¹² shows that over a fifth of monitoring is carried out by volunteers and is unfunded, including “nearly all of the invertebrate voluntary recording schemes as well as other plant, invertebrate, mammal, amphibian and reptile recording schemes”. This useful report identifies many other issues pertinent to this inquiry: that there is insufficient baseline data and data on long term trends in soil biodiversity, that many monitoring activities have incompatible databases so that information cannot be brought together to inform policy, and that the highest risks to good environmental monitoring are (inadequate) funding and staff continuity.

Funding for nationally important science of this sort must come from Government, its agencies and research councils. As we have asserted in our answers to other questions, this must recognise the need for long term funding, support for collections and monitoring, support for outputs that are not rewarded via the RAE, and support for training in field work, laboratory and identification skills.

Q5. How does funding in other countries compare? Could there be more international collaboration? If so, what form should this collaboration take and how might it be achieved?

A5. In Poland more respect is given to evolutionary biology, taxonomic work and systematics – even small universities have departments of evolutionary biology. We could certainly learn from our eastern European colleagues. Many UK graduates in biology finish university without being able to use an identification key.

A member of our working group worked with colleagues at the University of Lodz in Poland on a Leonardo da Vinci project to bring 21 Masters graduates to the UK for six months for work experience¹³. Many of them were employed here because they could identify to species level a range of organisms (especially plants, freshwater and terrestrial invertebrates). In Poland they maintain a classical education and science graduates studying botany or zoology possess good identification skills. Several of them have gained permanent employment here in the UK because of their taxonomic skills – which are far ahead of our own graduates.

Although this is good news, it would be unwise to assume that we can always purchase – and retain – skills in the market place when we need them. We cannot expect to bring in experts from overseas with expertise in specific diseases (such as Bluetongue) fast enough to identify suspected cases, for instance.

Q6. What impact have developments in DNA sequencing, genomics and other new technologies had on systematics research? In what way has systematics embraced new technologies and how can these research areas interact successfully and efficiently?

A6. Molecular science and technologies continue to benefit systematics research and taxonomy, and supplement but cannot replace traditional methods in most cases. For example, molecular biology has made identification of new microbes relatively cheap and rapid, but under current rules one has to be able to grow a new microbial species in order to name it – sequencing its DNA only allows a provisional name to be allocated to a presumptive new species. At the same time, bulk gene-sequencing approaches have revealed that the number of bacterial species still to be

¹² http://www.erff.org.uk/reports/reports/reportdocs/enviro_monitoring.pdf

¹³ <http://www.leonardo.org.uk>

described is much greater than previously thought: probably at least 100 times as many as the 8000 or so species currently named.

We expect that pocket sequencing technologies being developed for military applications will soon become more widely available and cheap enough for use by both professionals and amateur systematic biologists. In theory, this could allow identification of a known species from its DNA, without the need for morphological identification by an expert. But the quality and quantity of taxonomic data in DNA databases is a major limitation to the usefulness and accuracy of such approaches for the foreseeable future. Skills in traditional taxonomy will always be required to assign a DNA sequence to a particular species in the first place. And discovering new species is where the fieldwork gets exciting and becomes taxonomy.

Once data in DNA databases are of the necessary quality for a significant number of species of interest, this technology could free up the time of expert taxonomists for identifying new species, rather than for helping others to confirm the identity of known species.

We recommend a major funding initiative to improve the quality, compatibility and usability of molecular taxonomic databases, since these have the potential to revolutionise systematics and taxonomy.

Data collection, management, maintenance and dissemination

Q7. Does the way in which taxonomic data is collected, managed and maintained best meet the needs of the user community? What is the state of local and national recording schemes?

A7. A standardised format for taxonomic databases is crucial to allow data to be compared across databases. Small databases could usefully be combined to make them more useful and accessible. Climate change research requires long term datasets, and these need a critical mass of data before they become useful.

Recorder groups provide a considerable amount of data at county level. Recorders are people with taxonomic expertise, often retired academics or talented amateurs, who take responsibility – as volunteers – for recording the species of their ‘group’ of organisms. For example, there will be recorders for mosses and liverworts; ants, wasps and bees; flora; birds etc. The recorders feed this information into County Biological Record Centres and to the National Recorder for their group. They also give information to wildlife trusts. They produce atlases such as the Flora of Counties or County Bird Atlases. These books include detailed information on the ecology, morphology and distribution of a wide range of species.

Local and national recording schemes are patchy. Some taxonomic groups are well recorded (such as birds, butterflies and dragonflies), whilst some groups are omitted from records as there may not be someone within a particular county able to identify them. One county has appointed a fish recorder after a 20-year gap. Most recorders send their records to a national recorder for their group and some submit their data to the National Biodiversity Network (NBN) gateway.

Recording work is entirely voluntary. County Biological Records Centres are being downgraded in many areas. The Hertfordshire recording group is currently trying to encourage its recorders to put their records into electronic formats and to lodge copies with the local Biological Records Centre. **The NBN is a very positive development for taxonomy, but is still evolving and**

deserves more support.

Q8. What is the role of the major regional museums and collections? How are taxonomic collections curated and funded?

A8. Museums and collections are vital. They may be the only places to look at specimens to confirm identification. Regional and national museums and collections are also now the main location for research that was once done in universities.

The collections of Biological Resource Centres (BRCs), such as botanic and zoological gardens, culture collections and natural history museums, have traditionally been strongholds of taxonomy- and biodiversity-related science in the UK. We feel that these world-class assets need to be maintained. Their funding should be secure and long-term. These organisations house considerable taxonomic expertise (traditional and molecular), have access to the expertise of retired and honorary researchers and in most cases the relevant, worldwide scientific community. Ideally, we would like to see more funds available for post-doc positions and studentships and to give visiting experts a base. These measures would allow the survival of current knowledge and knowledge enhancement, through research and knowledge transfer from visiting experts and the opportunity to foster excellence in the systematists and taxonomists of the future.

Q9. What progress has been made in developing a web-based taxonomy? How do such initiatives fit in with meeting demand for systematics and taxonomy information? How do UK-led initiatives fit in with international initiatives and is there sufficient collaboration?

A9. Web-based taxonomy is a useful development, with real potential to provide cheap access to data. Users need to be able to follow a dichotomous taxonomic key. We believe that the keys are too hard to use at present and should be simplified.

Web-based information is getting better all the time but quality control is an issue, especially when inviting amateurs to provide data. An open peer review model might be a way forward.

We recommend that it should be a condition of publication of taxonomic research for the data to be deposited in a web-based database, in the same way that DNA sequence data must be deposited. This would require an infrastructure to be developed.

Q10. What needs to be done to ensure that web-based taxonomy information is of high quality, reliable and user-friendly?

A10. Web-based taxonomy information should be similar to that produced by facilities that collate DNA sequence information, ie a core facility with long term funding that can give continuity and adapt to feedback. This would allow the consistent presentation of data from multiple inputs across the biological sciences community.

The production of a good dichotomous key is vital, using high resolution photographs showing the confirming or key features. Those of us who use a microscope see little likelihood of a replacement for a text version.

Training modules on web-based and molecular taxonomy should be incorporated into relevant postgraduate courses, and made available to practicing taxonomists who wish to update their

knowledge and skills.

Q11. *How does the taxonomic community engage with the non-taxonomic community? What role do field studies play?*

A11. There is strong empirical evidence for the benefits of outdoor education for all age groups¹⁴ but biology fieldwork continues to decline in schools¹⁵.

Field studies and ecology field trips are especially valuable. They provide memorable, inspiring and enriching experiences for the participants. They train people in the correct sampling and collection methods and in core identification skills. These skills need constant reinforcing: 'learning by doing'. The engagement of taxonomists with students is the main way in which many interact with the 'non-taxonomic community'.

Some counties run a program of field days for the general public, focusing on a particular group of organisms. Natural History Societies are keen to encourage new members (especially younger members) to participate. Recorders are often happy to act as mentors, but the uptake can be disappointing.

Skills base

Q12. *What are the numbers and ages of trained taxonomists working in UK universities and other organisations?*

A12. We are not aware of a source of data on the numbers of taxonomists, the age structure of the profession and future needs.

The University of Hertfordshire has three trained taxonomists, all over 50 years old. Data on the number and age structure of the Herts recorders group is provided under Q1a.

We understand that the ERFF will shortly be conducting a survey to identify the skills needs and training priorities in the environmental science sector for the next ten years. **We urge** the select committee to encourage ERFF to include taxonomy and systematics in this survey, with additional government funding if necessary.

We recommend the learned societies and professional bodies that represent taxonomists and systematists to collaborate in conducting and publishing periodic surveys of their members in order to collect a time series of data which can be used to substantiate (or refute) concerns that the skills base is at a critically low level, and to share these data with ERFF and others. (This is a part of recommendation 1.)

Q13. *What is the state of training and education in systematics and taxonomy? Are there any gaps in capacity? Is the number of taxonomists in post, and those that are being trained, sufficient to meet current and future needs across all taxonomic subject areas?*

A13. We are worried by the decrease in teaching of field skills, identification skills, whole-

¹⁴ <http://www.field-studies-council.org/documents/general/NFER/NFER%20Exec%20Summary.pdf>

¹⁵ <http://www.field-studies-council.org/reports/biologyfieldwork/report1/index.aspx>

organism work and lab skills in schools and at undergraduate level in the UK. This is caused by several factors, including reduced funding and (sometimes unfounded) health and safety concerns. HEFCE reduced funding for subjects with lab and field-based elements (the ratio of financial support for laboratory based subjects compared to humanities was reduced from 2.0 to 1.7, resulting in a loss of more than £1,000 per student per annum). And university biosciences departments – like physics departments – are running at a deficit of 25-30%, according to a preliminary study commissioned by the Heads of University Biological Sciences (HUBS)¹⁶. These factors mean that universities may be compelled to axe the most expensive elements of courses, including lab and field work, so that undergraduates are unlikely to get the hands-on biology experience needed for a career in taxonomy and systematics.

Anecdotal evidence suggests that students coming from school to study biological topics as undergraduates no longer know or can name the body parts of a plant or insect, nor can they identify common species such as garden birds or buttercups. Degree courses and modules covering systematics and taxonomy have been removed from many universities, fewer degree courses in ecology, botany and zoology are on offer, few students graduate with taxonomic skills, and few taxonomists are now employed by universities. While we would expect that some traditional courses will disappear and new ones will replace them – as a welcome mark of a university system that responds to changing needs and priorities – **the UK continues to need scientists who can read a taxonomic key, have experience in whole-organism biology, and possess fieldwork skills.**

A 1997 survey of university teaching by the UK Systematics Forum found that around 60% of the universities that responded taught systematics as an optional or compulsory unit at elementary level; and only a third of the respondents offered more advanced level teaching in the subject¹⁷.

The UCAS web site shows 33 institutions offering UK zoology degrees (not combined with other subjects), seven offering botany degrees, seven for ecology, and 26 for environmental science. In contrast, 138 institutions offer degrees in business studies. There are no undergraduate degrees in systematics or taxonomy, but a few at Masters level.

Education at all levels is needed. A number of specialist bodies such as the Marine Biological Association¹⁸ provide education and outreach activities, and could do more if funded.

An interesting initiative which we believe should offer a model for the future is the Masters bursary scheme funded by the Defra Marine Aggregate Levy Sustainability Fund¹⁹. Defra has responsibilities for licensing, including extraction of sand and gravel from the seabed, and Ministers agreed that a levy should be placed on this industry, known as the Marine Aggregate Levy Sustainability Fund (MALSF).

The MALSF Steering Committee recognised that – while there have been significant advances in understanding the nature and scale of impacts of marine aggregate dredging on physical, historic and biological resources – knowledge remains incomplete for much of the coastal waters in England. There is virtually no information on whether localised impacts on seabed communities that are potential food for fish have a detectable effect on ecosystem function and fisheries of

¹⁶ <http://www.brad.ac.uk/acad/lifesci/HUBS/Meetings/2007November/Report/ReportHUBS20071114.pdf>

¹⁷ http://www.nhm.ac.uk/hosted_sites/ukstf/web_of_life/education/index.htm

¹⁸ http://www.mba.ac.uk/education/education_outreach.php?education

¹⁹ www.alsf-mepf.org.uk

economic significance. To improve training in systematics, MALSF has supported a bursary scheme for Masters students. Four students are now participating, and at the time of writing (January 2008) their project work has yet to be finalised.

We recommend funding for specialist courses and training fellowships in strategic subjects where there is an identified skills gap. Universities that run specialist courses can then build up the team, expertise and critical mass to resurrect the skills base and attract overseas students to gain further funding.

Openness

We are pleased for this response to be publicly available and will be placing a version on www.britishecologicalsociety.org , www.bsf.ac.uk and www.iob.org . For any queries about this response, please contact Barbara Knowles, Institute of Biology, b.knowles@iob.org

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