

## Role of on-line species information systems in taxonomy and biodiversity

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### The importance of species names

Species are the most practical and widely applicable measure ("international currency") of biodiversity, and the only one with a well-established standardised code of nomenclature. The presence and absence of species in check-lists can be tools for biodiversity assessment, nature conservation management, pollution monitoring and assessment, and taken over time provide measures of ecosystem change (colonisation theory, community equilibrium, etc.). The Convention on Biological Diversity defines biodiversity as the variation within species, between species, and of ecosystems. The species concept is clearly central to all these approaches. For example, geographically isolated populations, and differences within a species whether ecological, physiological, or morphological all provide measures of within species biodiversity. The species concept itself defines variation between species, and assemblages of species characterise the state of ecosystems. More recently, the relatedness of species is being developed to provide a 'phylogenetic' measure of biodiversity that recognises the evolutionary history of species. In this, samples of equal number of species but more families or phyla are regarded as having greater biodiversity.

However, there are problems in using species lists. Firstly, lists may exclude species because: undiscovered species may be given the name of a known relative; and observers may fail to correctly recognise a species. Secondly, species may be given the wrong name because of: inadequate identification guides; insufficient taxonomic training; unknown literature; and errors and oversights by the identifying person. These problems generally result in underestimates of species richness.

### Benefits of the internet

Imagine the time saved by taxonomists and increased accuracy of people identifying species, if they could search accurate information on (a) correct (and incorrect) species names, (b) species habitat and ecology, (c) distribution, (d) identifying features, within minutes on the internet. Instead of spending hours seeking out rare publications and studying (or overlooking) them, scientists would rapidly be able to give a correct name to observed specimens, or describe it as a new species. Once described, knowledge of the new species would be rapidly available through the Internet, minimizing the likelihood of others wasting their time describing the species under a different name. This rapid access to quality-controlled information would allow easy entry of young scientists, students and amateurs into the field of study. On-line polychotomous visual identification keys will make identification easier and allow for decreased training periods for taxonomists. I suggest that the construction of on-line species information systems will be excellent value-for-money in overcoming the taxonomic impediment to describing biodiversity. In addition, such information systems are in any case required for effective research and management of marine biodiversity (both within species, between species, and of ecosystems). Correct names and species identifications (i.e. taxonomy) are the basis for quality control in biodiversity research and management.

### On-line species information systems

The establishment of a globally accessible database of all species names has begun. Species 2000 ([www.sp2000.org](http://www.sp2000.org)) is a federation of databases with species names and synonyms that are (or soon will be) available on-line for all world taxa. The North American Integrated Taxonomic Information System is a similar all-taxon initiative ([www.itis.org](http://www.itis.org)) with a centralised database at its core. For marine species the most comprehensive regional all-taxon list of species is the European Register of Marine Species (ERMS). A global list of marine species that contributed to ERMS is the UNESCO Register of Marine Organisms (URMO) (<http://www2.eti.uva.nl/database/urmo/default.html>). All of these initiatives are working closely together to avoid overlap and so achieve a world list as soon as possible.

The species lists are only the first step in a full information system. They need to be linked to information on 'other names', geographical distribution, ecology, identification, and management importance (e.g. social, commercial, conservation). The lists and their associated information are most effectively edited by the taxonomic experts. The compilation of species lists not only produces a useful list, but also has added benefits in networking specialists, and developing working relationships amongst experts that enable additional projects to be developed and funded.

The first step in compiling such information systems is a 'dictionary' of species names. The European Register of Marine Species (a project funded under the European Commission MAST research programme), compiled the first list of species in Europe's seas. This project produced a list of 28,000 species in two years on a budget of 385,000 Euro. It involved a partnership of 22 organizations, 170 contributing scientists, and links with 42 other organizations. The lists were published on the world wide web ([erms.biol.soton.ac.uk](http://erms.biol.soton.ac.uk)) and as a book. The project also identified over 600 experts from 37 countries in the identification of marine species that occur in Europe, and their age structure did not suggest that taxonomists were all retiring into extinction. However, coverage of expertise was very uneven, with fewer experts for the most species rich taxa. An analysis of the 840 available identification guides showed that most series were out of date, and that there were fewer guides where there were most species, namely for the Mediterranean and southern parts of the European Atlantic ocean. Other impediments to information availability were that few museums had the resources to enter data from their collections into databases; thus awareness of what information they had was very limited.

ERMS directly contributed to the successful launch of Fauna Europaea, a project that will list all terrestrial and freshwater fauna in Europe ([www.faunaeur.org](http://www.faunaeur.org)). A parallel project aims to revise the already published Flora Europaea into an on-line database on all land plants in Europe (Euro+Med Plantbase). The database of experts established by ERMS is being built upon by the BIOMARE marine biodiversity research network ([www.biomareweb.org](http://www.biomareweb.org)). Comparable initiatives are being launched elsewhere in the world, such as the Centre of Marine Biodiversity ([www.marinebiodiversity.ca](http://www.marinebiodiversity.ca)) in Atlantic Canada. The ERMS list is now being converted into an on-line relational database.

The Census of Marine Life ([coml.org](http://coml.org)) aims to produce a census of all species in the world oceans from the past, present and future. Its dataserer is the Ocean Biogeographic Information system ([iobis.org](http://iobis.org)) which brings together data both through linking federated databases, and/or archiving data in a central database; and then provides on-line sets of environmental data and analytical (e.g. GIS, statistical) tools for users. For example, the gulf of Maine Biogeographic Information system (GMBIS) brings together data from fishery cruises and museum collections into an on-line GIS. OBIS is an associate member of the Global Biodiversity Information Facility (GBIF, [www.gbif.org](http://www.gbif.org)) and the leading marine data provider to GBIF. The next few years will see ERMS developing into an on-line atlas that will contribute to OBIS and GBIF, and so enable analysis of data beyond the European scale.

All of the above mentioned projects and initiatives are committed to making information on marine species freely available through the internet. Only people and organizations willing to make their data available in this way can participate in these initiatives. The internet provides a new outlet for rapid publication that can be as quality controlled as any other publication. Good science demands such rapid publication. Unlike conventional libraries, there are no permanent archives of electronic data, but these are being developed (e.g. OBIS). It should become a requirement of 'good practice' in biodiversity research to lodge data into on-line databases, just as it is to lodge type specimens of a new species into a museum. The internet is becoming a critical tool in taxonomy, primarily by facilitating the rapid communication and publication of species information. It also enables ecologists and environmental managers to have more rapid access to quality data. Increased automation of data retrieval and analysis through new on-line software tools will provide an added level of service to educators, researchers and environmental managers. With this, the demand for skilled taxonomists will increase rather than decrease because of the need for quality control of the underlying biodiversity data.