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Biodiversity Informatics in Germany: ongoing projects and their possible contribution to the Global Taxonomy Initiative (GTI)

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Abstracts

Several major biodiversity informatics projects in Germany can be considered as important modules for building up the national Global Taxonomy Initiative. Examples are the Entomological Data Information System (<http://www.insects-online.de/>), which will bring together important entomological collections housed at different museums within one "Virtual Museum" (for Orthoptera: see <http://www.dorsa.de>). Another example is the "Global Register of Migratory Species" (<http://www.groms.de>), a cross-sectional database and geographical information system, specialising on migratory species. Finally, there is the "Inventory of biological research collections in Germany (ZEFOD)", collecting metadata on biological collections in Germany (www.genres.de/zefod).

Key Words: Biodiversity informatics, museum collections, migratory species

Introduction

European museum collections contain important type material from all over the world, and therefore play a key role for any taxonomic work based on these reference collections. Traditionally, taxonomists made a "pilgrimage" to visit the collections relevant for their group of interest, to examine and photograph type specimens. With the rise of the WorldWide Web, it is possible to provide museum information on-line, thereby facilitating access to lists of type material, pictures or any other information related with type specimens. Due to the federal political landscape of Germany, there are several museum collections of similar importance, which means that the material is even more scattered than in other European countries, such as Britain and France (Fig. 1). By digitising this scattered information, it can be published on the WWW as one "Virtual Museum", facilitating access and provide a "virtual centralisation".

As an example, I present the EDIS- project (Entomological Data Information System), highlighting data sets elaborated by the sub-project DORSA, which is digitising Orthoptera type specimens housed in German museums. EDIS forms part of a major German Research & Development network supported by the German federal ministry of education and research (www.bmbf.de) called BIOLOG (Biodiversity and Global Change), focussing on terrestrial biodiversity research and biodiversity informatics. The sub-programmes on biodiversity informatics are organised into clusters focusing on groups of organisms, such as fungi, higher plants and insects. Applied fields are represented (e.g. phytopathogens), as well as molecular systematics (for details, see <http://www.bgbm.org/BioDivInf/biolog/Projektliste.htm>). It is evident that all of its bioinformatics components are relevant both for the Global Taxonomy Initiative (GTI) and the Global Biodiversity Information Facility (GBIF).

In addition, there are several on-going biodiversity informatics projects focussing on conservation biology, supported by the Federal Environmental Ministry (www.bmu.de) through the Federal Agency of Nature Conservation. As an example, I describe the Global Register of Migratory Species (GROMS: www.groms.de), which has been designed to support the UNEP Convention on the Conservation of Migratory Species of Wild Animals (CMS: <http://www.wcmc.org.uk/cms/>).

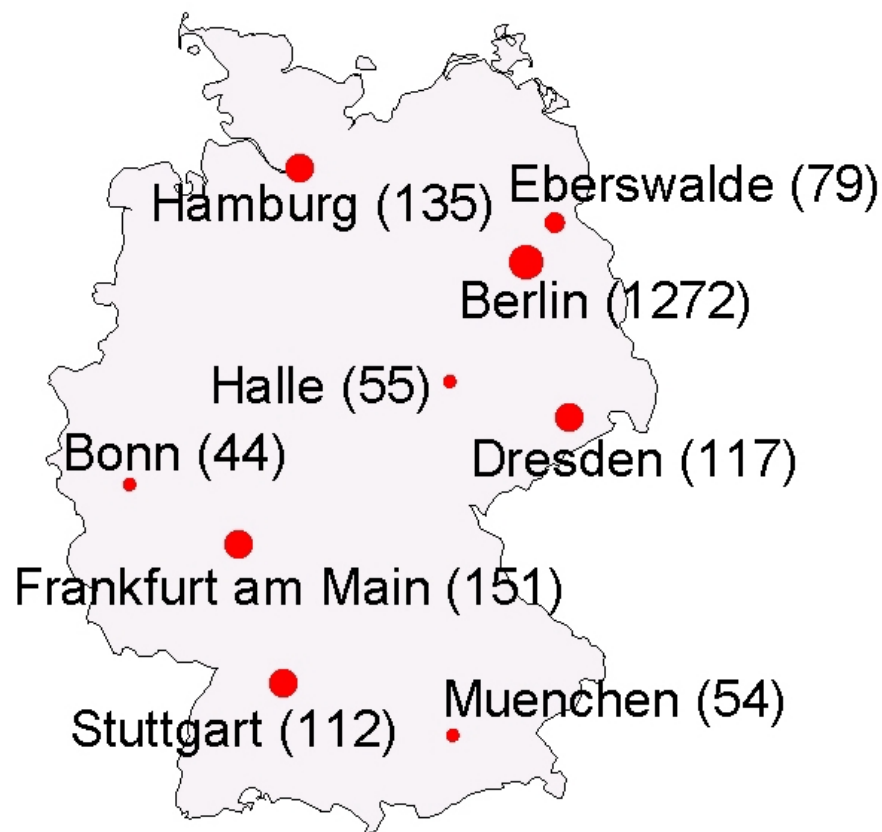


Fig. 1 Orthoptera (crickets and grasshoppers) collections in Germany – number of holotypes in major museums. A similar distributed pattern is observed for type material of other groups of organisms housed in German museums or research institutions.

Collection databases: EDIS - DORSA

The Entomological Data Information System (EDIS: www.insects-online.de) is supported by the German Federal Ministry of Education and Research to provide access to relevant information about insects and other arthropods for research and the general public and to promote digitisation of the data distributed over various entomological collections in Germany in a comprehensive database. DORSA (Deutsche Orthopteren-Sammlungen - German Orthoptera Collections) is a specimen based database with internet access to the Orthoptera held in German museum collections including geographic information on a world-wide basis as well as media data like illustrations of type specimens and sound recordings

(“Virtual Museum”; overview: Lampe and Riede 2001). The aim of the sub-project DORSA is to provide database access to important Orthoptera (grasshoppers and crickets) specimens in German research collections. DORSA will be internet-linked to the global species database 'Orthoptera Species File' (OSF: <http://OSF2.orthoptera.org/basic/HomePage.asp>), which provides the taxonomic backbone of the specimen database (for a comprehensive description of OSF, see Eades 2001). DORSA includes multimedia information such as pictures and insect sounds (December 2002: 4,000 sound files and 20,000 pictures). Based on the DORSA song database, a rapid assessment tool is developed for automated song recognition (Dietrich et al. 2002)

As a first result, the majority of type specimens in German research museums has been checked and databased. Mapping of type distribution on a country level reveals a focus of German collections on South East Asia and Australia (Fig. 2).

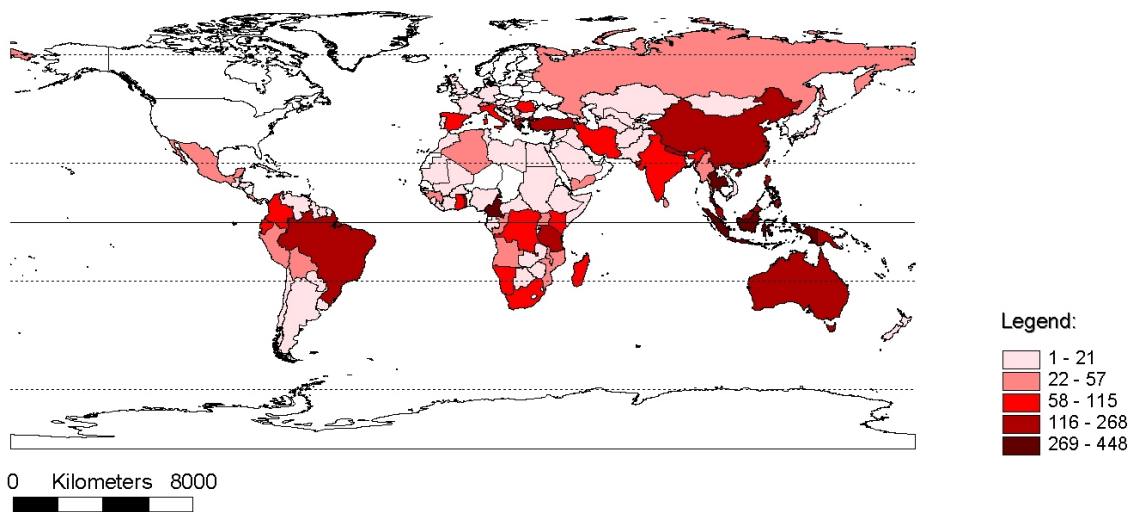


Fig. 2 Distribution of Orthoptera type specimens (including Para- and Lectotypes) housed in German Museum collections. Note the high number of types from Africa, South East Asia and Australia, collected in the last centuries and described by F. Karsch (1891a, b, 1893), W. Ramme (1929, 1940) and Y. Sjöstedt (1921, 1935) [only major papers].

Locality information is now refined further by geo-referencing localities, which can be visualised by a Geographic Information System (GIS). A web-based GIS mapping tool is already available at www.dorsa.de. It is based on approximately 1,200 localities of katydid (Tettigonioidae) sound records made by K.-G. Heller (cf. Willemse & Heller 2001).

Meta-Databases: ZEFOD

The example from EDIS-DORSA presented above illustrates the complex situation of botanical and zoological collections in Germany. Analysis and web-presentation of these collections has reached different stages of progress. Meta-data giving an overview of collections are presently collected by ZEFOD (“Inventory of biological research collections in Germany” (ZEFOD) - www.genres.de/zefod). The aim is to provide structural and content-oriented descriptions of biological collections in Germany, to be published as an expandable, interactive information network for a broad range of users in science, administration and the general public. ZEFOD is part of the BIOLOG network. In addition, ZEFOD is constituting

the national node for the European BioCASE ("Biodiversity Collection Access Service for Europe", see also Güntsch et al 2001) and is a direct contribution to international initiatives like the Global Taxonomic Initiative (GTI)', the Convention on Biological Diversity (CBD), and the 'Global Biodiversity Information Facility (GBIF)'.

Conservation database: GROMS

Among the major long-term goals of biodiversity informatics is to provide data for conservation. Meanwhile, conservationists have established a parallel universe of information infrastructure, mainly focussing on vertebrates and environmental data (Tab. 1).

Tab. 1: Examples of major information networks focussing on conservation. Most of those are focussing on higher vertebrates

Acronym	full name	Website	focus	type	Status
BCIS	Biodiversity Conservation Information System	www.biodiversity.org/simplify/ev.php	networking	framework; network, conservation	In progress
BLI	BirdLife International	www.birdlife.org	Threatened birds, Important Bird Areas	expert network, database	Book publications, web fact sheets
IUCN Red List 2000	IUCN Red List 2000	www.redlist.org	Threatened species	Database	Published on Web and CD
IUCN SIS	IUCN Species Information Service	www.iucn.org/themes/ssc/sis/sisuse.htm	species data sets, threat analysis, customised products	information system based on expert network	planned
UNEP-WCMC	UNEP World Conservation Monitoring Centre	www.unep-wcmc.org.uk/	environmental data, information brokerage, species database	Organisation, databases, GIS environmental datasets	multiple information services, including species databases for CMS and CITES
FishBase	FishBase	www.fishbase.org	A Global Information System on Fishes	Database, network	Published as CD, book and Web

One of the main users for these products are the secretariats of Multilateral Environmental Agreements committed to species and habitat conservation, such as Ramsar, CITES and CMS (Ramsar: The Ramsar Convention on Wetlands: www.ramsar.org; CITES: UNEP Convention on International Trade in Endangered Species of Wild Fauna and Flora: www.cites.org; CMS: UNEP Convention on the Conservation of Migratory Species of Wild Animals:

<http://www.wcmc.org.uk/cms/>). In the mid-1990s, the CMS Secretariat became aware that scientific information on migratory species within the CMS definition was scattered and very difficult to collect. With the development of new technologies such as increasingly powerful computers, networks and the Internet, the idea was born to develop a special database that could become the focus for any research on migratory species. The aim was to have this database provide an additional tool for fact finding and decision-making by the bodies of CMS and related regional Agreements and Memoranda of Understanding (MoU). It was also intended that the database would be available on the Internet to serve as an additional information tool on migratory species within, *inter alia*, the Clearinghouse Mechanism of the Convention on Biological Diversity (CBD).

The database has now been published on the WWW (www.groms.de) and as a CD-ROM, together with an extensive report (Riede 2001). Because migration is observed in a wide variety of species,

distinct information sources had to be evaluated, ranging from species databases to GIS datasets. The experiences gained during data integration for such a cross-sectional database might be useful for the ongoing process of harmonising biodiversity informatics initiatives. At present, GROMS has concentrated on migratory vertebrates, but even within this comparatively well-studied group major inconsistencies concerning taxonomic reference lists were observed (Figure 3).

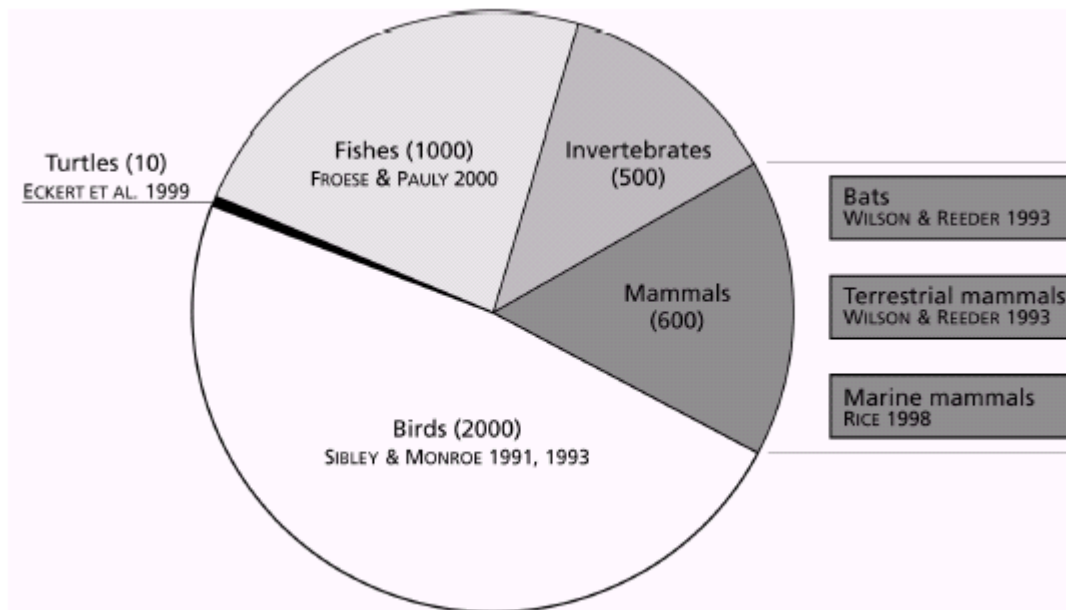


Figure 3: Taxonomic reference lists used by CMS, the GROMS and several other conservation databases. In brackets: number of migratory species.

For fishes, the taxonomic backbone provided FishBase (www.fishbase.org) was an excellent starting point. Because it is available as a database on CD-ROM, transfer of species names was easy. Therefore, GROMS could concentrate on its core task: identification and key-wording of the migratory status of fishes as diadromous, anadromous, or oceanodromous (McDowall 1988). Future data exchange between both databases is facilitated by a direct hyperlink, which allows switching from GROMS to Fishbase on the World Wide Web.

For birds, considerable nomenclature differences complicated data exchange with a variety of sources, requiring management of synonyms and parallel taxonomies. Given the huge number of ornithologists, and the comparatively low number of unknown species, it is strange that there is still no „Birdbase“ available. Taxonomic problems were even worse on the level of subspecies, where the GROMS seems to provide the first digitally available subspecies list of migratory non-passerine birds. Such a higher taxonomic resolution is necessary for an adequate assessment of migration behaviour, which differs between populations. Therefore, effective conservation plans will have to take into account such a higher level of taxonomic resolutions. In addition, an efficient management of population data requires links to museum specimen databases and gene banks.

The taxonomic inconsistencies became particularly obvious during integration of data from the IUCN Red List 2000 in its digital format (Hilton-Taylor 2000). Using the scientific name, automatic linkage of the GROMS and IUCN databases for approximately 90% of the common 600 threatened migratory species. But the remaining species were „overlooked“ due to minor differences in spelling (*Lepidochelys kempii* vs. *L. kempii*) or different taxonomies. Besides simple differences in nomenclature (bowhead whale: *Physeter catodon* - *Physeter macrocephalus*), most differences resulted from controversial classification of subspecies as full species (e.g. gorillas, or albatrosses, see Robertson & Nunn 1997). In several cases, english names turned out to be more stable and reliable for database linking than scientific names!

An effective management of such controversial taxonomic views would require a much more sophisticated database scheme, using „potential taxa“ (Behrendsohn 1995). However, it is evident that databases used in conservation should use common taxonomic standards. Though most conservation databases cite the same taxonomic reference lists, there are in practice still considerable deviations, because most of the taxonomic authority files are not available in digital format. The case of the GROMS demonstrates that time-consuming checks „by hand“ were necessary to harmonise and link different databases, even for species-poor groups such as vertebrates!

Discussion and perspectives

There is a great potential for digitised museum information and other resources, but the task ahead is huge. The complex situation described above for Germany is also observed at the next higher, European level. Meanwhile, the Biological Collection Access Service (BioCase: www.biocase.org) project has been launched, and will hopefully remedy the situation. Due to the continent's colonial past, European type collections are particularly important for tropical countries. Therefore, providing improved collection access using web-based technologies should be among the top priorities and responsibilities of the European biodiversity research agenda.

Another important task is an improved transfer of biodiversity information between conservationists and scientists. Museum collections harbor a huge amount of information on historic species distribution, and could provide answers to difficult taxonomic questions. An increasing amount of this information is now available on-line, and it is therefore high time to provide effective links between museum and conservation databases. A prerequisite for an effective information exchange is a general availability and acceptance of taxonomic authority files, which is among the core tasks of the Global Taxonomy Initiative.

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