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Taxonomy and EDIT – Toward of European Distributed Institute of Taxonomy*

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ABSTRACT. Taxonomy with its countless contributions generated much taxonomic knowledge over the past. However, it is now weakened by decades of neglect. Taxonomy is not a service to other biological disciplines, but an integral part of evolutionary biology. Taxonomy is essential for rational assignment in conservation biology. Facing the biodiversity crisis, the need to rebuild expertise and infrastructure is clearly visible. The reasons of ‘taxonomic impediment’ are recognized by the EU and responsibility to help to resolve the problems is taken. The project EDIT — “Toward the European Distributed Institute of Taxonomy”, supported by European Union by 11.9 million € for years 2006–2010 comprises 27 partner institutions in Europe, Russia and USA. It will aim to coordinate the European contribution to the global taxonomic effort with the Global Taxonomy Initiative (GTI), in and outside Europe. Organisation, operational structure, objectives, aims and activities of EDIT are briefly announced.

Key words: European Distributed Institute of Taxonomy, EDIT, taxonomy, biodiversity.

The first step in wisdom is to know the things themselves; this notion consists in having the true idea of the objects; objects are distinguished and known by their methodical classification and appropriate naming; therefore Classification and Naming will be the foundation of our Science

C. LINNAEUS (1735)

The laws of biology are written in the language of diversity

E. O. WILSON (1989)

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Europe is the cradle of scientific taxonomy and has the most comprehensive collections in the world. Although the research effort related to these collections is notoriously insufficient to allow full exploitation of their potential, European taxonomists and institutions are still responsible to help resolve the ‘taxonomic impediment’ at a global level.

The term “taxonomic impediment” was used by IUBS/Diversitas to describe the lack of taxonomic expertise and information to handle the enormous task of identifying and naming biodiversity (HOAGLAND 1996). Describing biodiversity is lagging far behind 1) discovery of new biodiversity, and 2) extinction of biodiversity. In recent years there has been a number of different opinions on what to do about the slow rate of publication of new species descriptions. Numerous papers on the taxonomic impediment and their respective responses appeared recently (WHEELER *et al.* 2004; LYAL & WIETZMANN 2004; MARTIN 2004; GEETA *et al.* 2004; CAUSEY *et al.* 2004; YOUNG 2004; CARVALHO *et al.* 2005, FLOWERS 2007a, b; EVENHUIS 2007). Some see the impediment as a complex interaction of low funding and slow adoption of new molecular techniques and informatics, others see it in the work habits of individual taxonomists (WHEELER *et al.* 2004; EVENHUIS 2007; FLOWERS 2007b). While even the most recent may argue the details, they clearly all agree that we still lack taxonomic expertise to adequately describe the biodiversity on this planet.

Taxonomy with its countless contributions generated much taxonomic knowledge over the past. However, it is now weakened by decades of neglect, suffers the loss of positions and funding of studies that reconstruct phylogeny but don’t improve formal classification, or biodiversity and ecology studies that give no application of scientific names, etc. Biological sciences entered the 21st century with tensions among “phylogenetic biology”, “molecular taxonomy”, “biodiversity” studies and “classical taxonomy”. Although phylogeny studies, particularly capitalised by molecular phylogenetic analyses, are commonly cited as evidence of active taxonomic research, the ‘real’ taxonomy is hecatombed. Numerous articles and letters claim the relative importance of DNA technology versus morphological traits in modern taxonomy and biodiversity studies. Its advantages and disadvantages (MALLETT *et al.* WILLMOTT 2003; SEBERG *et al.* 2003; LIPSCOMB *et al.* 2003; TAUTZ *et al.* 2003; FITZHUGH 2006a, b). Numerous “biodiversity” studies add only more question marks and mess to the knowledge, without formal descriptions (“morphospecies 1, 2, ..., genus A, species a, genus A species b, etc.), because lack of taxonomic expertise. Taxonomy seen as a time-consuming hindrance is believed to be inconvenient in areas of exceptional biological richness, so the concept of so-called recognizable taxonomic unit (RTU) was developed. The importance of taxonomic background in ecological studies was discussed by WOODCOCK (2003), stating “...even a minimal level of taxonomic training could dramatically increase the accuracy between biological species and RTUs”. Descriptive taxonomy, morphologybased taxonomy is believed to be passé (WHEELER 2004). Taxonomy is perceived to face a lack of prestige and resources and not to attract large-scale funds in the same way as other huge programs like Human Genome Project (GODFRAY 2002a).

We live in an era of elevated rates of extinction, yet about 90% of the Earth’s species of animals, plants and micro-organisms remain undescribed (WILSON 2004).

Taxonomy, the description and classification of living things, has its origins in ancient Greece and in its modern form dates back 250 years, to when Linnaeus introduced the binomial classification still used today. Linnaeus, of course, hugely underestimated the number of plants and animals on Earth (GODFRAY 2002a). Taxonomy is often considered a purely descriptive science. It has been under siege for much of the last century, accused as ‘soft’ science, as ‘not hypothesis driven’ science. The task of inventorying is often mistaken for ‘stamp collecting’, as taxonomy is collectionbased science. These views are obviously not true: descriptive aspects of taxonomy are scientific in their own right and taxonomy is not ‘soft’ with rigorous theories and methods. Only few disciplines have witnessed such profound theoretical revolutions as taxonomy (HENNIG 1966; NELSON et PLATNICK 1981; SCHOCH 1986; FOREY et al. 1992; SCHUH 2000). Modern species descriptions are based on syntheses of a broad range of different data, including DNA or other molecular features (WINSTON 1999; ESSELSTYN 2007). The Linnean system, based largely on morphological features, has served biology extremely well for over 250 years. Taxonomy will be advanced by appropriate and prudent dependence on both DNA and morphology (LIPSCOMB et al. 2003; DUNN 2004). Such information is a prerequisite to proper formulation of evolutionary or ecological questions. Taxonomic knowledge and expertise is basic for collection-based informatics systems and for biodiversity analysis (GRAHAM et al. 2004). There are various projects aimed at listing e.g. all the valid described species of animals in Europe, butterflies on Earth, or data on species distribution (GRAHAM et al. 2004). These aims are eminently achievable and worthwhile, but the results are raw, unexciting and of relatively little value by themselves to non-specialists (GODFRAY 2002a). Taxonomy is not a service to other biological disciplines, but is an integral part of evolutionary biology. Taxonomy is essential for rational assignment in conservation biology. Facing the biodiversity crisis, the need to rebuild expertise and infrastructure is clearly visible.

The taxonomic impediment, the lack of sufficient taxonomic skills, information and capacity is well-known and has been well-lamented over the past years (GODFRAY 2002b; WHEELER 2004; ENGHOFF et SEBERG 2006). Evenhuis (2007) argued another aspect of the taxonomic impediment – some of the existing taxonomists are not doing much or even any taxonomy. There are numerous legitimate reasons for this inactivity – most having to do with squeezing their taxonomic research in between other obligations such as administration, bioinformatics, phylogenetic analyses that do not name new taxa, non-taxonomic research, teaching, travel, meetings, etc. Many taxonomists are now “molecular systematists”, because they found that funding would be impossible otherwise. The lack of interest shown by these taxonomists (from laziness, career burnout, administrative duties, etc.), which is a serious problem, ultimately contributing to the decline of taxonomy as a science and loss of positions (ZHANG 2007). Not all taxonomists follow these dictates as presented in an interesting survey of European and Australian beetle specialists (LÖBL et LESCHEN 2005). Unfortunately, the situation for taxonomists has seemingly not improved. In contrast to many other fields of science, taxonomy is rather slow to learn. Many reasons for this slowness are closely related with the over 250-year long history of taxonomy.

Taxonomic papers are not just pieces of paper with scientific information, they are also ‘legal’ documents to some extent. Containing descriptions of new taxa and other acts as ruled by the International Codes of Nomenclature, taxonomic papers last virtually for ever (MINELLI 2003). The old original descriptions, often in rare and inaccessible books, have to be consulted and ancient geographic names have to be traced. For a detailed comparison the original and the type specimens need to be consulted, and so the museum where these types are stored needs to be traced and specimen sent by post to the examiner. On today’s academic market, a ‘publish or perish’ world, the journal where the paper is published is a fundamental (or the only) criterion for assigning resources, the score of taxonomy is clearly very poor. Most of the journals publishing taxonomic papers fail to reach the pages of ISI Journal Citation Report and, in consequence, their impact factor is 0.00. Taxonomic monographs, because of their size, are often published as books, which means they are not mentioned by abstracting and bibliographic services. Products of collections-based taxonomic research, monographs, identification keys, catalogues, faunas, floras, etc. cannot be fairly assessed by standard bibliometrical measurements, which must be taken into account by scoring and decisionmaking bodies.

The impediment in publishing has a huge negative impact on taxonomy. It is increasingly more difficult to publish papers on descriptive taxonomy in a timely and cost-effective manner. It is common for a taxonomist to wait eight to twelve months and sometimes even years to get a paper published. Unless there is access to an institutional monograph series, it is even more difficult to publish a large taxonomic revision or monograph, not only because of costs, but the fact that most journals are of a fixed size and have limits on the length of papers. The delay and difficulty in getting works published discourage taxonomists who had worked for years and unpublished works are a huge waste of talent and resources. Large monographs are particularly important to the study of complex species-rich taxa, as taxonomy is about comparison, and closely related species must be compared together (ZHANG 2006b). To remove these impediments in taxonomy, and to help systematists rapidly document the world’s zoological diversity, which includes many undescribed species now threatened by the rapid habitat loss (ZHANG 2006a), a web-based journal “Zootaxa” was established in 2001. Before 2006, sections of “Zootaxa” were taxon-oriented. In 2006, a new section, “Theory and Methodology”, was introduced to facilitate the publication of papers discussing general issues in systematic zoology (ZHANG 2007). Another opportunity was given by GBIF (Global Biodiversity Information Facility), as well as by many private enthusiasts, who designed websites for their favourite taxa (ARAGES 2007; GdO 2007; HAAS 2006). A proposal for establishing an autonomous system (ZooBank of names as GenBank of DNA sequences) for registration of nomenclatural acts could put taxonomic papers on the same footing as other scientific papers and significantly increase their average quality and visibility (MINELLI 2003; POLASZEK et al. 2005). The essential problem which still slows down the learning of taxonomy is that it involves learning of shapes and colours, which cannot be done directly from the literature alone. It requires comparing specimens and remembering the characters. Details often matter only after comparison, so

one needs to re-examine specimens again. Details may vary, so one needs to see much material to remember and distil the essentials of shape and colour. For many taxa, very few specialists world wide will be able to cover most possibly arising needs. Therefore regions, such as the European Union, and countries should coordinate when vacancies are filled or new jobs created in taxonomy. In total, we are talking about 4.000 to 6.000 professional taxonomists worldwide, which is very little personnel. The same applies to the design and assembling of collections (HAAS 2006). A number of articles have appeared recently, discussing the nature of ‘taxonomic crisis’ and potential strategies to overcome it (see WHEELER 2004; ENGHOFF et SEBERG 2006; ESSELSTYN 2007).

Taxonomists need to agree on deliverable projects that will receive wide support across the biological and environmental sciences, and attract public interest. Being at a crossroads, having impressive past, having documented and organized knowledge of nearly 2 million species, taxonomy needs revitalization. Taxonomic researches are urgent due to the environmental ravages of the biodiversity crisis. They are absolutely necessary for progress in conservation and in biological research in general. The challenges for taxonomy have been identified (GODFRAY 2002a; WHEELER et VALDECASAS 2005; DAYRAT 2005), argued and discussed (ENGHOFF et SEBERG 2006; ESSELSTYN 2007).

According to the decision VI/8 of the 6th Conference of Parties to the Convention on Biological Diversity, taxonomy could be defined as follows:

“Broadly understood, taxonomy is the classification of life, though it is most often focused on describing species, their genetic variability, and their relationships to one another. For the purposes of the Convention taxonomy is taken in its broadest sense and is inclusive of systematics and biosystematics at the genetic, species and ecosystem levels.”

There are several levels or kinds of taxonomic activities (ENGHOFF et SEBERG 2006):

1. Recognition, description and naming of taxa (a nearly equivalent definition of alpha-taxonomy). Alpha-taxonomists describe, name, revise and synonymise taxa.
2. Comparison of taxa, including studies of relationship (phylogeny) (a nearly equivalent definition of a part of beta-taxonomy).
3. Classification of taxa (a nearly equivalent definition of a part of beta-taxonomy). Beta-taxonomists compare and classify taxa, create phylogenies.
4. Study of (genetic) variation within species (a nearly equivalent definition of gamma-taxonomy). Gamma-taxonomists study infraspecific variation.
5. Construction of tools for identification (e.g. keys for identification, DNA barcodes). Tool-makers construct keys and other identification tools.
6. Identification of specimens (using the tools);
7. Inventories of taxa in specific areas or ecosystems (using the tools for identification). Tool-users identify specimens, make inventories, check-lists, catalogues.

Taxonomic research currently suffers from four types of fragmentation and access problems:

1. Its results are fragmented across 250 years of literature and much of the collected 'legacy data' is inaccessible to the vast majority of users, and the taxonomists themselves find that this fragmentation has become a heavy handicap for research preventing taxonomy from achieving its full potential as an enabling science;
2. The most comprehensive resources are restricted to those key institutions (particularly museums and herbariums) with extensive collections and libraries;
3. Even for the few users with easy access to these institutions, the taxonomy of any given group of organisms still remains scattered in many different formats across many publications, and more recently in differently formatted databases of variable quality: at present only one documentary centre on animal taxonomy in Europe can provide more than 85% of the original descriptions of the 3139 European animal species new to science discovered between 1998 and 2003 (FAUNA EUROPAEA 2007), and the position is far worse in medium and small centres;
4. Unlike many disciplines, taxonomy has traditionally been a relatively solitary exercise instead of an integrated enterprise with specialists on particular taxa working together.

Furthermore, many producers of new taxonomic information are not employed as taxonomists. Between 1998 and 2003, over 50% of the 3139 newly discovered European animal species have been described and named by non-professional taxonomists. The major museums and herbariums of the world are the obvious core centres able to promote the integration of taxonomy in a structured way. Most taxonomic information is created and remains accessible only on paper and in dispersed collections of specimens, as it was in Linnaeus's time. Taxonomy is a field in which the state of the art changes fast, both through knowledge of previously unknown species, and through acquisition of new kinds of data such as molecular sequences. The fragmentation of taxonomic resources means that at present even researchers lack access to fundamental information essential for the development of effective strategies and policies for conservation and understanding biodiversity changes. Developing taxonomic research and sharing information with the countries of origin to contribute to their capacity building in taxonomy are key objectives of the Convention on Biological Diversity. These can be achieved only through a strong and coordinated action of those European institutions with the relevant expertise and collections and also the training capabilities.

The project EDIT is a "Network of Excellence", with full name: "Toward the European Distributed Institute of Taxonomy" (EDIT 2007). It is supported by European Union by 11.9 million € for years 2006–2010. EDIT partnership includes holders of large amounts of data, it comprises 27 partner institutions from Belgium, Denmark, France, Germany, Hungary, the Netherlands, Poland, Slovakia, Spain, United Kingdom, Russia and USA + non-governmental organizations: Species2000 and SMEB.

Project EDIT will aim to coordinate the European contribution to the global taxonomic effort with the Global Taxonomy Initiative (GTI), in and outside Europe, through:

1. Production of new knowledge,
2. Search to ensure complementarity of expert capacities through coordination of training and recruitment strategies,
3. The provision of the skills necessary for a taxonomic task force for inventories,
4. Developing a programme of expert training both to enhance skills and to fill gaps,
5. Implementing the integrated information infrastructure to feed the Clearing House Mechanism and the GBIF, which provide the general portals for access to taxonomic and other biodiversity information worldwide,
6. Making the information housed in the collections and the taxonomy based on them better available to the countries of origin.

EDIT will collaborate with the GTI in strengthening the infrastructure for biological collections in the country of origin and the transfer of modern technologies for taxonomic research that are represented within the EDIT consortium. The overall objective of EDIT is to integrate European taxonomic effort within the European Research Area and to build a worldleading capacity. EDIT will create a European virtual centre of excellence, which will increase both the scientific basis and capacity for biodiversity conservation (EDIT DoW 2005).

The operational and structural objectives of EDIT are:

1. To reduce fragmentation and to transform taxonomy into an integrated science;
2. To strengthen the scientific, technological and information capacities needed for Europe to understand how biodiversity is modified through global change;
3. To progress toward a transnational entity by encouraging durable integration of the most important European taxonomic institutions, forming the nucleus of excellence around and from which institutions and taxonomists can integrate their activities;
4. To promote the undertaking of collaborative research developing, improving and utilizing the bio-informatics technologies needed;
5. To create a forum for stakeholders and end-users for taxonomy in biodiversity and ecosystem research;
6. To promote the spreading of excellence to fulfill the needs of biodiversity and ecosystem research for taxonomybased information.

EDIT will address significant information and management of knowledge problems in a rapidly changing field. The issues to be addressed are structural: about governance and management; about providing a suitable Information Techniques environment; about the development of new tools; and about getting taxonomists to work as one

across European (and other) institutions. EDIT will bring together the leading taxonomic institutions in Europe that for historical reasons have developed independently. The association with leading North American and Russian partners will make it a worldwide leading network. The consortium so constituted unites the premier natural history collections-based institutions to progress toward EDIT's structural and scientific objectives. It is the intention of the current EDIT membership to extend membership progressively. EDIT aims at addressing these significant information and management of knowledge problems in a rapidly changing field. The overall objective of EDIT is to integrate European taxonomic effort within the ERA and to build a world leading capacity. This will provide better access to a more unified and better quality taxonomic research information base, particularly for:

1. those users who assess changes in biodiversity and protect it against decline,
2. those who are dedicated to understanding ecosystem functioning, and
3. other taxonomists.

EDIT aims at playing a key role in the creation of new knowledge and the adoption of new methods and tools in order to optimise the use of the taxonomic resources held by the partner organisations for the substantial benefit of European research capacity on the conservation of biodiversity. EDIT will create a European virtual centre of excellence, which will increase both the scientific basis and capacity for biodiversity conservation across the European Research Area. EDIT intends to make some of the extant resources available for gaining new information on little-known taxa and unexploited gaps in taxonomic knowledge. EDIT will address the needs of four concentric circles of stakeholders:

1. EDIT founding members, which will lead the effort to integrate research;
2. Other members of CETAF, who will provide a European forum for EDIT;
3. Those taxonomists working outside these institutions, yet contributing significantly to the taxonomic effort;
4. The wider user community, including citizens, researchers on biodiversity and ecosystems, industry, and managers of biodiversity at all levels.

In the international context where overcoming the "taxonomic impediment" has become a major concern of the Convention on Biological Diversity, EDIT has a major responsibility as constituting by far the largest taxonomic resource in the world. EDIT brings together the leading taxonomic institutions in Europe that for historical reasons have developed independently. It also involves six universities and one public research institute that are primarily not collectionsbased and whose prime expertise is in biodiversity and ecosystem research. The association with leading North American and Russian partners will make it a worldwide leading network. The European Union collection-holding core members of EDIT are also members of the Consortium of European Taxonomic Facilities (CETAF). CETAF was established by the Directors of taxonomic institutions in 1996 to stimulate cooperation and collaboration. Russian

and North American institutions are being proposed for inclusion in EDIT due to the magnitude and quality of their collections and expertise. As a structuring effect of European Union supported programmes, Dutch, Belgian, Polish and Slovakian members are grouped into national consortia (NL-TAF, BE-TAF, PL-TAF and NATAF), of which the first three have been constituted to manage access to infrastructures within the frame of the EU 3I programme SYNTHESYS. In addition to these institutions, the consortium includes two network organisations devoted to management of species data, at EU and world level, and one non-collection based research institute devoted to dissemination of information on scientific knowledge and innovation in the fields of agriculture and environment. Six members of the consortium belong to universities. The consortium so constituted unites the premier natural history collections-based institutions, which have both the management capacity and the will to progress toward EDIT's structural and scientific objectives, and the EU-based network organisations devoted to management of species data. Their collections are global in coverage and are supported by complementary expertise. More than half of the world's natural history specimens, which constitute the large scale infrastructure for taxonomic research, are held in the repositories of EDIT's membership. The EU and Russian participants of EDIT employ about 1100 active professional taxonomists and doctoral students, of whom more than 600 of the EU participants have expressed their interest. The core groups of researchers, aimed at reaching a total ca. 200, will be defined when the network is actually set up. In part A, the actual numbers have been reduced in function of a rough estimate of their availability for integration. It is the intention of the current EDIT membership to extend the consortium to include wider representation from the New Member States and Associated States. It is also the intention of EDIT founding members to extend membership progressively to CETAF members and other institutions.

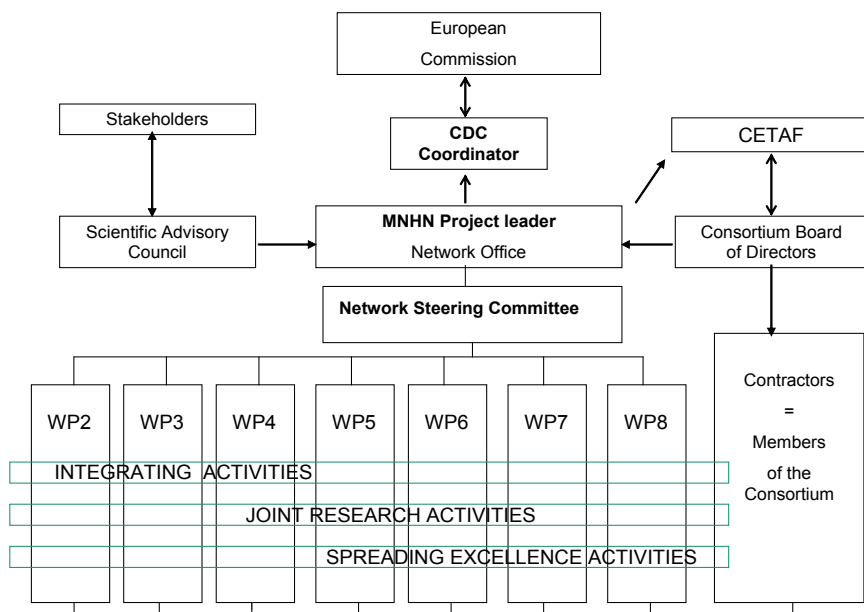
Project EDIT is led by Museum national d'Histoire naturelle in Paris. Administrative and financial issues of EDIT are coordinated by the Caisse des dépôts et consignations (CDC). Decision-making bodies are: Board of Directors (BoD), Network Steering Committee (NSC) and Scientific Advisory Council (SAC).

Short descriptions of objectives, aims and activities of Work Packages is given below (EDIT DoW 2005; EDIT 2007).

Work Package 1 — EDIT Coordination and Management

Objectives:

1. Establish and operate the management structure, involving the top executive level of the partners, with the objective of ensuring long-term operational and structural links between partners through open-ended agreements regarding infrastructure, expertise, research and training.
2. Coordinate the activities regarding research, infrastructures and expertise towards common goals integrated at director's level for implementation of further common decisions, aiming at combining all work packages objectives into a single integrated sustainable structure.



Coordination
and integration

Resources

Products

WP1

WP2

WP3

WP4

WP5

WP6

WP7

WP8

EDIT operational structure is organized in eight work packages (WP)

3. Coordinate interactions with stakeholders, including communication with institutional stakeholders.
4. Establish and update the roadmap of EDIT, including plans to enlarge the consortium.
5. Ensure internal and external communication of EDIT, and its visibility in the Web.

Aims:

To progress toward the integration of institutions with different histories, sizes, national legislative frameworks, status, regulations and policies will be demanding. Integration necessarily involves less autonomy. Like other large bodies, taxonomic institutions have to be convinced that the advantage of integration overcomes the possible handicaps, in particular large institutions where the taxonomic capacity achieves the critical mass for maintaining a sustainable structure. The role of WP1 is to synthesise progress made step by step in the work packages and plan further progress through interaction of the advisory bodies with the WP leaders and the top executive level of the partners.

Activities:

1. **Establishment and operation of the administrating structure, including coordination of the WPs:** Network Office, Network Steering Committee, Board of Directors, including coordination of the WPs.
2. **Orientation, sustainability and development of exploitation strategies for EDIT:** operate the Scientific Advisory Board; orient EDIT activities according to the users' needs and the capabilities of the partners; establish mechanisms allowing sustainability of integration, and sustainable development of activities beyond the term of the contract.
3. **Communication (internal/external):** establish and operate the website; make all EDIT partners aware in real time of progress in the activities; provide an internal forum where activities and directions can be discussed internally to all participants; make the taxonomic community external to EDIT aware of EDIT activities and encourage its support and participation; promote EDIT and taxonomy in forums dedicated to biodiversity and beyond.
4. **Liaison programme coordinating the *ad hoc* liaison groups established by WPs:** maintain coherence and impulse common direction among the liaison groups established for various goals in the different work packages.
5. **Gender action plan:** promote gender equality in all activities: gender balance, gender awareness for men and women in EDIT, promotion of women in science, family-friendly policies.

Work Package 2 — Integrating the expert and expertise basis

To remedy fragmentation of the expert and expertise basis, work package 2 aims at obtaining an overview of the European taxonomic expert and expertise basis and its relation to the global expert and expertise basis, and making information on the taxonomists and taxonomy basis easily available for all potential users. By coordinating the recruitments strategies of the EDIT partners, facilitating exchange of staff and supporting networks and taxonomic societies, this work package will allow reduction of fragmentation and contribute to the integration of the experts who together form the European taxonomic workforce. Taken together, European taxonomists constitute a potentially extremely powerful workforce to deal with the abovementioned chal-

lenges. However, the European expertise is currently badly fragmented by taxa (e.g. botanists/zoologists, entomologists/other zoologists, etc.), by countries, by institutions, and by status of the experts (professional/amateurs), resulting in a suboptimal use of both human and financial resources: the rate of experts per taxon is extremely uneven, and needs for expertise have overall little effect on recruitment strategies because we have no vision of the existing forces. By integration, efficiency will be increased in three ways:

1. Access to the experts by users of taxonomic information will be greatly facilitated.
2. Formation of targeted taskforces to deal with specific tasks will become much easier.
3. A coordinated recruitment strategy will help optimizing the investment in human resources.

Objectives:

The activities of this WP will serve to reduce fragmentation and contribute to the integration of the experts who together form the European taxonomic workforce. It is EDIT's intention to maintain and strengthen Europe's position as a stronghold of taxonomic scientific expertise, and to make taxonomic information more readily accessible to stakeholders in biodiversity and ecosystem research and management.

1. Evaluating the European workforce.
2. Formation of EDIT Task forces.
3. "Early warning" system.
4. Mobility of researchers.
5. Increasing the participation of amateur taxonomists.
6. Sustaining networks created for other taxonomic EU projects.
7. Integrated recruitment strategy.

Aims:

There is up to now no rational organisation of complementarity of expertise among large taxonomic institutions, who often duplicate competences and do not fill the needs for taxonomic knowledge and expertise in little studied taxa altogether. It is the intention of EDIT to coordinate recruitments and provide information on the current state of the European taxonomic expertise in order to optimize a workforce which most probably will not increase much overall in the next years.

Activities:

1. Information service on taxonomic experts ;
2. Information service on ongoing taxonomic projects;
3. Taxonomic societies and networks;
4. Mobility of researchers;
5. An integrated recruitment strategy for taxonomists.

Work Package 3 — Integrating the infrastructure basis

The main objective of this work package is to come to a unified vision for the preferred infrastructural basis at the European level, and to prepare the design of the new integrated infrastructure for implementation, which, once decided at director's level, will be formalized through Memoranda of Understanding (MoUs). The challenge is to bring together the separate components and to add scientific value for such a next generation infrastructure. **Adaptation and collaboration of the European taxonomic infrastructures are necessary to establish the institutional and digital networks which will be able to answer to the demand for taxonomic information.** The central objective is to come to a unified vision for the preferred infrastructural basis at the European level, and to prepare the design of the new integrated infrastructure for implementation, which, once decided at director's level, will be formalized through MoUs. The challenge is to bring together the separate components and to add scientific value for such a next generation infrastructure. The ambition to achieve such an integrated approach will find quite some barriers on its way, since it requires substantially different work processes, ranging from setting a distributed physical facility (remote microscopy, bar-coding) to agreeing on a common management structure, through agreement on shared standards and processes. However, the commitment of the EDIT partnership will be a driving force to promote institutional and professional changes. The whole EDIT network will contribute to this work package, also in close coordination with WP 2 and WP 6.

Objectives:

The Integration of physical infrastructures.

Aims:

The EDIT network identified two barriers to overcome in relation to the ambition to 'construct' a new infrastructure consortium from the present situation.

- Barriers to institutional change: the ambition to implement a new integrated infrastructure will have consequences for each separate institutional policy, and may even sometimes have legal implications. National legal systems and sentiments have to be overcome in order to create joint operations and decision mechanisms. In addition, it is expected that resistance to transfer of activities or facilities will hamper the anticipated progress. Open procedures, information and leadership are crucial to overcome these barriers.

- Taxonomic paradigms and routines: a basic problem in biodiversity informatics is that although names are critical metadata for biological information, up to now no reliable mechanisms exist to prevent wrong or ambiguous returns (of data objects) of the results from different databases. More strongly, this holds for provisional taxonomic identities, such as un-named molecular taxonomic units. This hampers the development of proper methods for (automated) cross-referencing of taxonomic concepts and attached biodiversity information. Another constraint is that potentially innovative solutions in a digital environment should be preferably complemented with the adaptation of

different codes of taxonomic nomenclature, which now still have their roots in the printed information environment.

Activities:

1. Network of the physical taxonomic infrastructures;
 - Complementarity and Integration,
 - The concept of Biological Resource Centres,
 - Economics of physical infrastructures.
2. The taxonomic information infrastructure network;
 - The taxonomic information backbone,
 - European Taxonomic Information Services,
 - Bioinformatics toolbox facilities.
3. Sustaining the cybertaxonomy process;
4. Prototypes of large-scale networked instrumental facilities;
 - Organisation of the European contribution to the DNA bar-coding efforts,
 - Advanced Remote Microscopy in Europe.
5. Liaisons with international infrastructures.

Work Package 4 — Coordinating

This work package addresses the scientific and cultural impediments which hamper development of new taxonomic knowledge to fulfill the needs of scientific and other stakeholders, including top management levels. Fragmentation reduces the impact of the high quality of current European research in all the fields of taxonomy in a broad sense, as it is understood by the Global Taxonomy Initiative of the Convention on Biological Diversity. Challenges facing taxonomy (to fully discover and describe the species on the Earth and to study the patterns of diversification – to explore and document life on the Earth) are too immense to be solved by the approaches of the past. It is essential that taxonomists approach their work on a scale appropriate to meet the current decline in biodiversity. It is necessary to test and make accessible the existing information and generate new knowledge around prioritised taxa-driven objectives, around biodiversity-rich geographical regions and/or ecosystems, or focus on hot spots of biodiversity. This requires a cultural change among taxonomists, who now need to function as a community, and the resolution of many consequent issues, of which the least is not making innovative research accessible to all researchers in taxonomy to induce a new dynamics of the community. This new dynamics can make it possible to meld the theoretical taxonomic advances of the twentieth century with the emerging technologies of the twenty-first century to maintain and enhance the excellence of the experts that has marked taxonomy, while expanding and expediting its work according to the user communities' requirements. By this cultural shift and by promoting the application of the appropriated cutting edge technologies (digital, molecular), the ERA can recover its historical leadership in taxonomic research and promote and strengthen its view in political and economic decisions in sustainable development, global changes and ecosystems research.

Objectives:

1. Maximise the efficiency and scientific excellence of the extant organizational effort by promoting synergies among research teams within EDIT and beyond.
2. Link taxonomic research with societal requirements (end user communities).
3. “Scientific alertness”: Explore prospecting areas for future collaborative projects. This will include emerging research topics and new tools and technologies for taxonomic identification.
4. Develop a durable integrated research agenda for the EDIT roadmap.
5. Organize competitive calls for tender and follow up projects.

Aims:

Competition is the basis for evaluation of researchers, and the resulting trend to individualism is still encouraged by fragmentation of the expertise. Most often, the expert of a taxon has more affinities with experts of the same taxon working in other institutions than with his colleagues working on other taxa. Providing the common tools will probably not be sufficient to overcome this major barrier, and EDIT Coordinating Research WP will create incentives towards the necessary common new culture, both intellectual through discussions and meetings aiming at developing innovative approaches, and through support of projects which will be called for with a strong constraint on integration of the research proposed. At institution level, coordinating research agendas with the objective of integrating into the EDIT roadmap will also be demanding, and will be addressed through constant interaction with other WPs, and from the researchers level to the NSC level. On the user side EDIT has to prove its efficacy in communication and in providing the information required by end-user communities quickly and in appropriate forms.

Activities:

1. Integrating research projects within and beyond EDIT;
2. Design and establish mechanism for calls for tender and follow-up of projects;
3. Liaison research/end-users;
4. Scientific alertness;
5. Progress toward an integrated Research agenda.

Work Package 5 — Internet Platform for Cybertaxonomy

One of the major impediments to full usage of the existing taxonomic research potential is the lack of a common and networked platform for taxonomic work processes such as taxonomic revisions, biodiversity inventories, and monitoring. The overall purpose of work package 5 is to harness the advanced biodiversity informatics expertise of the partner institutions into a focused effort for a European joint taxonomic research structure. Progress has been made over the past decade to network taxonomic resources in the areas of specimen and taxon information and specialist knowledge. The networks created by projects like ENBI, EuroCat or BioCASE provide access to individual institutional resources or to the output from such resources. However, they

have not significantly changed the institutions' information production process, priorities, or documentation and IT structures. The community thus remains fragmented in its approach to applied biodiversity informatics. **One of the major impediments to full usage of the existing taxonomic research potential is the lack of a common and networked platform for taxonomic work processes such as taxonomic revisions, biodiversity inventories, and monitoring.** Through its work package "Internet platform for cybertaxonomy" (WP5), EDIT aims at:

1. Demonstrating exemplary integration mechanisms in the area of informatics for taxonomy.
2. Raising scientific efficiency by significantly reducing the number and/or duration of steps involved in the taxonomic research and publication/dissemination process.

An EDIT set of software programs and standards, specified, tested and implemented within the project and maintained and enhanced beyond the project's period in the spirit of open source software development, will not only forge an institutionalised European biodiversity informatics community, but also keep the development open for use and contributions through institutions not taking part in the initial network.

Objectives:

The overall purpose of WP5 is to harness the advanced biodiversity informatics expertise of the partner institutions into a focussed effort for a European joint taxonomic research structure.

1. Promote specification, testing and implementation of an EDIT set of software programs and standards, together forming a platform for the taxonomic work process including revisionary taxonomy, and all taxa biodiversity inventories and monitoring.
2. Integrate activities of the partners' IT departments into a collaborative structure.
3. Achieve a "distributed institutionalisation" of responsibilities, i.e. individual institutions taking the lead in a defined area and making that area a longterm priority.

Aims:

An important sociological barrier is the additional workload scientists face when creating re-usable information resources. This will be addressed by an incremental approach to software development, with tangible output at any stage, thus easing the scientist's way from the traditional printed publication approach to the creation of such multi-purpose resources. The initial phase of workflow modelling will play an essential role in identifying major bottlenecks in the process and developing strategies for their removal. An organisational barrier is posed by the different structures and sizes of the IT sections and departments at participating institutions, with most of them lacking biodiversity informatics research capabilities that can support the ongoing taxonomic work. Efforts to obtain additional funding to build IT capacity will be supported by EDIT, so that IT people from these institutions are enabled to participate in the project. A concerted effort will be made, with the aim of identifying successful structural models and suggesting their implementation. Another organisational barrier which has to be overcome throughout the network is to ensuring the longterm maintenance of high-quality taxonomic information and the supporting authority files by appropriate

mechanisms of institutional commitments. WP5 will address this barrier in all software development tasks by means of application of professional tools for source code documentation and versioning, thus greatly reducing subsequent maintenance costs. During the last two years of the project, an activity within WP3 will specifically address the sharing of responsibility for longterm maintenance of the software components constituting the Platform.

Activities:

1. Integration of Informatics and IT departments; over-all WP5 coordination;
2. Creating the Internet Platform for Cybertaxonomy;
3. Auxiliary taxonomic data repositories;
4. Geographical platform components.

Work Package 6 — Unifying Revisionary Taxonomy

This workpackage is focused on what is termed revisionary taxonomy, which includes analysis and synthesis of taxonomic concepts to create new knowledge. Revisions typically include:

- introductory information on a group of organisms;
- its taxonomic history;
- descriptions of species and higher taxa;
- keys for, or other means of, identification;
- citation of specimens, including type specimens;
- bibliographic citation, with the broad aim of establishing a scientifically sound classification of the units of biodiversity: species.

Phylogenetic analysis is explicitly a part of many revisions or implicitly provides the framework for the results. This work package is focused on what is termed revisionary taxonomy, which includes analysis and synthesis of taxonomic concepts to create new knowledge. Revisions typically include:

- introductory information on a group of organisms;
- its taxonomic history;
- descriptions of species and higher taxa;
- keys for, or other means of, identification; citation of specimens, including type specimens;
- bibliographic citation, with the broad aim of establishing a scientifically sound classification of the units of biodiversity: species.

Phylogenetic analysis is explicitly a part of many revisions or implicitly provides the framework for the results. The taxonomic information base is currently fragmented, as is the effort of the taxonomists that work on the groups. By the end of the five-year period, it is expected that unified revisions will have been undertaken for subsets of the demonstrator taxa and that the work of constructing the expert taxonomic networks will show the means by which integrated effort of taxonomists can be achieved. A further aim is to encourage, by example and encouragement, the construction of further expert taxonomic networks. The long-term aim of the WP, which extends beyond the project, is to create a mechanism for revisionary taxonomic effort to be better integrated and

its multitudinous and distributed results migrated to a common web-environment for each taxon. Better integration of effort by the community of researchers is essential to achieve these ends and this will require backing from the senior management of participating institutions. Technical developments are necessary, but not sufficient to deliver these ends.

Objectives:

1. Define and develop the means to provide access to the currently highly fragmented information sources.
2. Formulate the construction of expert networks in the form of distributed taxon-specific committees to manage taxonomic effort across institutions.
3. Define closely what is needed from the cyber-environment for taxonomic Web content to be delivered.

Aims:

The barriers are cultural, organisational and technical. The greatest challenge is to encourage taxonomists to work together on selected taxa in teams and distributed networks to define focused goals and develop taxonomic knowledge bases with web-based revisions forming a central component. They include issues relating to intellectual property, including crediting authors and their institutions appropriately for input into the rich collaborative outputs we envisage as taxonomy becomes more integrated and Web-based. The sustainability of Web-based taxon sites will require institutional commitment and harmonisation of effort, and we will work towards these ends.

Activities:

1. Content structure and presentation;
2. Define what is needed from the cyber-environment;
3. Community structuring by management committees and expert taxonomic networks;
4. Publication within the web-environment.

Work Package 7 — Applying taxonomy to conservation

The establishment of an ATBI+M (All Taxa Biodiversity Inventory & Monitoring) task force network is expected to support the integration of the taxonomic community throughout Europe, and also to substantially increase the capacities for efficient protected area management on a local, regional, and international scale. For this work package, therefore, it will be important to draw from experiences of and connect to relevant initiatives and programs in Europe (e.g., Fauna Europaea, Euro+Med PlantBase, Species2000, MARBEF), as well as internationally. In close cooperation with all partners of the EDIT consortium, the outcomes of this work package will make a significant contribution towards the implementation of the Global Taxonomy Initiative Programme of Work, particularly at the European level. The increasing need of sound taxonomic information and expertise for the successful implementation of biodiversity policies and management programmes has been expressed widely at European and international fora. With the prevailing political focus on the establishment of an effective

global network of protected areas for biodiversity conservation, efforts supporting an efficient inventorying and monitoring of biodiversity in existing and proposed protected areas seem particularly pertinent. The restructuring of the taxonomic community through EDIT should enable European taxonomists to take a leading position in the fields of biodiversity inventories, monitoring and assessments towards the year 2010 and beyond. Through the introduction of demand-driven processes into the taxonomic workflow, it should be possible to influence and stimulate research agendas, such as setting priorities for which taxa revisions or phylogenetic analyses would be most relevant in terms of user needs.

Objectives:

Within the framework of EDIT, the ultimate objective is to overcome the taxonomic impediment, to which this WP will particularly contribute by:

1. Strengthening the input of taxonomic expertise in Europe for biodiversity conservation programmes and policies, especially for inventories, assessments, and monitoring of biodiversity.
2. Integrating user needs for taxonomic expertise from the conservation management side with research agendas for biosystematics and biogeography from leading European centres of excellence.
3. Further developing and promoting standards, techniques and methodologies for state of the art and cost-efficient biodiversity assessments including a new approach for an “All Taxa Biodiversity Inventory & Monitoring” (ATBI+M) programme, which will help to establish a European expert task force for undertaking and supporting biodiversity inventories, assessments, and monitoring activities.

Aims:

A major challenge for the success will be to strike a good balance between individual and institutional research interests and the inventory and monitoring needs in protected areas. On the side of the taxonomic community and the individual scientists involved, it will require a change in attitude by accepting user requests for setting priorities in the location and specific goals for their field work. For the conservation community, it will require a better understanding of the need for taxonomic research beyond the actual identification of organisms, and the recognition of scientific research projects being conducted within protected areas supporting the cause of conservation. The proposed mechanism to accomplish the abovementioned WP goals is to establish teams for different groups of organisms integrating the expert base from the EDIT Partners and other institutions in Europe, which together will form a task force ready to be deployed wherever needed.

Activities:

1. Assessing biodiversity inventory and monitoring needs, evaluating relevant taxonomic capacities, and raising stakeholder awareness.
2. Mobilising taxonomic resources and establishing the ATBI+M task force network.
3. Developing standards, protocols, and tools for conducting an ATBI+M programme.

4. Operating the ATBI+M task force and evaluating relevant methods and techniques.
5. Sustaining the European ATBI+M task force and longterm study sites.

Work Package 8 — Training and Public Awareness

The work package 8 will stimulate the provision of more integrated courses and research training opportunities that bring together traditional taxonomy, molecular approaches, informatics, biodiversity and conservation management. In addition, to facilitate access to existing training courses, an essential task of EDIT will be to investigate ways and means to integrate all training resources into a coherent and widely publicised training programme, the “European School of Taxonomy”, which will encompass training for experts and curators from southern countries. European science is facing a tremendous loss of taxonomic expertise. Despite the availability of a welldeveloped taxonomic infrastructure, European taxonomic research, including management aspects in its collection, increasingly relies on an aging taxonomic community, with permanent staff often over 50 years old and with a significant input by retired researchers and skilled amateurs who frequently have to self-fund their research. Efforts to find enthusiastic young people with an interest in becoming qualified taxonomists are thwarted by insufficient training opportunities and a lack of long-term professional prospects. To address this problem, education is an essential component of EDIT. The main challenge is to stop the loss of taxonomic expertise, and have this negative trend reversed in 5-10 years from now. EDIT will strive to achieve this by increasing the transfer of knowledge and by establishing an integrated European training programme for taxonomy. In parallel, public education will increase the awareness of the vital contribution that taxonomy can make to biodiversity and ecosystem research and consistent lobbying will contribute to maintain the interest of the various decision-makers and funding agencies.

Objectives:

1. Encourage greater use of existing training courses and initiate new training opportunities;
2. Assess European strengths and weaknesses and create an integrated programme in the form of the European School of Taxonomy (EST);
3. Develop access to the EST for students and professionals and provide opportunities for mobility;
4. Raise the societal profile of taxonomy as one of the ‘big sciences’ by networking NHM-BG professionals dealing with public awareness.

Aims:

The barriers to the training are both structural and content-based. First, it is needed to overcome the fragmentation of the training offers, by making these better known, reducing redundancies and pooling efforts. Second, gaps must be filled through elaboration of new courses in areas where training is urgently needed. Third, taxonomic education must be made more enjoyable and more relevant to the needs of ‘twenty-first century taxonomy’. This addresses the need to better document the world’s biodiversity,

especially poorly known taxa, but also the adaptation to appropriate technologies to achieve its research. In order to overcome those barriers, established taxonomists must be given the tools and opportunity to transmit their knowledge. Attitude changes in the taxonomic community towards service delivery, especially in terms of education, need to be encouraged. Finally, structural support must be established, not only to provide resources for training, but also to put this training into practice, via the creation of adequate job opportunities. Being also centres of diffusion of taxonomy-based knowledge, NHM and BG are already on the way to reinforce their operational co-operation for co-producing and transferring products and best practices devoted to public awareness in natural sciences. EDIT is the adequate framework to get staff dealing with science and staff dealing with the public within taxonomy institutions closer.

Activities:

1. Assessment of the training resources for taxonomy in Europe.
2. Mobilisation of European training providers into EDIT's School of Taxonomy.
3. Establishment of pilot schemes for integration.
4. Implementation of EDIT's School of Taxonomy.
5. Public Awareness and Public Relations for the promotion of Taxonomy.

Detailed descriptions of all dealings of the project EDIT and its work packages are available via its web-site: www.e-taxonomy.eu. EDIT also publishes Newsletters to announce its activities.

REFERENCES

- ARAGES, 2007. Arachnologische Gesellschaft e.V. <http://www.arages.de/index.html>
- CARVALHO, M. R., DE BOCKMANN, F. A., AMORIM, D. S., DE VIVO, M., DE TOLEDO-PIZA, M., MENEZES, N. A., DE FIGUEIREDO, J. L., CASTRO, R. M. C., GILL, A. C., MCEACHRAN, J. D., COMPAGNO, L. J. V., SCHELLY, R. C., BRITZ, R., LUNDBERG, J. G., VARI R. P., NELSON G., 2005. Revisiting the taxonomic impediment. *Science*, **307**: 353.
- CAUSEY, D., JANZEN, D. H., PETERSON, A. T., VIEGLAIS, V., KRISHTALKA, L., BEACH, J. H., WILEY, E. O., 2004. Museum collections and taxonomy. *Science*, **305**: 1107.
- CONVENTION on Biological Diversity. <http://www.cbd.int/default.shtml>
- DARLING, J., 2006. The Value of Barcoding. *BioScience*, **56**(9): 710–711.
- DAYRAT, B., 2005. Toward integrative taxonomy. *Biological Journal of the Linnean Society*, **85**: 407–415.
- DUNN, C. P., 2004. Keeping taxonomy based in morphology. *Trends in Ecology and Evolution*, **18**(6): 270–271.
- EDIT DoW, 2005. Sixth Framework Programme Sub-Priority 1.1.6.3 “Global Change and Ecosystems”. Contract for: Network of Excellence – Annexe 1: Description of Work. 203 pp.
- EDIT, 2007. <http://www.e-taxonomy.eu>.
- ENGOFF, H., SEBERG, O., 2006. A Taxonomy of Taxonomy and Taxonomists. *The Systematist*, **27**: 13–15.
- ESSELSTYN, J. A., 2007. Should universal guidelines be applied to taxonomic research? *Biological Journal of the Linnean Society*, **90**: 761–764.
- EVENHUIS, N. L., 2007. Helping solve the “other” taxonomic impediment: completing the Eight Steps to Total Enlightenment and Taxonomic Nirvana. *Zootaxa*, **1407**: 3–12.
- FAUNA EUROPAEA, 2007. <http://www.faunaeur.org/>
- FITZHUGH, K., 2006a. DNA Barcoding: An Instance of Technology-driven Science? *BioScience*, **56**(6): 462–463.

- , 2006b. Response from Fitzhugh. *BioScience*, **56**(9): 711.
- FLOWERS, R. W., 2007a. Taxonomy's unexamined impediment. *The Systematist*, **28**: 3–7.
- , 2007b. Comments on “Helping Solve the ‘Other’ Taxonomic Impediment: Completing the Eight Steps to Total Enlightenment and Taxonomic Nirvana” by Evenhuis (2007). *Zootaxa*, **1494**: 67–68.
- FOREY, P. L., HUMPHRIES, C. J., KITCHING, I. L., SCOTLAND, R. W., SIEBERT, D. J., WILLIAMS, D. M., 1992. *Cladistics: A Practical Course in Systematics*. The Systematics Association Publication No. 10. Oxford University Press, Oxford, UK. i–xii+1–191.
- GdO, 2007. Gesellschaft deutschsprachiger Odonatologen. <http://www.libellula.org/>
- GEETA, R., LEVY, A., HOCH, J. M., MARK, M., 2004. Taxonomists and the CBD. *Science*, **305**: 1105.
- GODFRAY, H. C. J., 2002a. Challenges for taxonomy. *Nature*, **417**, 2 May 2002: 17–19.
- , 2002b. How might more systematics be funded. *Antenna*, **26**(1): 11–17.
- GRAHAM, C. H., FERRIER, S., HUETTMAN, F., MORITZ, C., PETERSON, A. T., 2004. New developments in museum-based informatics and applications in biodiversity analysis. *Trends in Ecology and Evolution*, **19**(9): 497–503.
- HAAS, F., 2006. Taxonomists and Users: two species that rarely meet. v3, updated 25 iv 06. <http://www.gti-kontaktstelle.de/TaxUsers.html>
- HENNIG, W., 1966. *Phylogenetic Systematics*. University of Illinois Press, Urbana-Chicago-London. 1–265.
- HOAGLAND, K. E., 1996. The taxonomic impediment and the Convention of Biodiversity. *Association of Systematics Collections Newsletter*, **24**(5): 61–62, 66–67.
- LINNAEUS, C., 1735. *Systema Naturae, sive Regna tria Naturae systematice proposita per Classes, Ordines, Genera, & Species*. Apud Lugduni Batavorum, Theodorum Haak, MDCCXXXV. Ex Typographia Joannis Willhemi de Groot.
- LIPSCOMB, D., PLATNICK, N., WHEELER, Q., 2003. The intellectual content of taxonomy: a comment on DNA in taxonomy. *Trends in Ecology and Evolution*, **18**(2): 65–67.
- LÖBL, I., LESCHEN, R. A. B., 2005. Demography of coleopterists and their thoughts on DNA barcoding and the Phylocode, with commentary. *Coleopterists Bulletin*, **59**: 284–292.
- LYAL, C. H. C., WEITZMANN, A. L., 2004. Taxonomy: exploring the impediment. *Science*, **305**: 1106.
- MALLET, J., WILLMOTT, K., 2003. Taxonomy: renaissance or Tower of Babel? *Trends in Ecology and Evolution*, **18**(2): 57–59.
- MARTIN, J. T., 2004. Taxonomists and conservation. *Science*, **305**: 1104.
- MINELLI, A., 2003. The status of taxonomic literature. *Trends in Ecology and Evolution*, **18**(2): 75–76.
- NELSON, G., PLATNICK, N., 1981. *Systematics and Biogeography: Cladistics and Vicariance*. Columbia University press, New York. i–xi+1–567.
- POLASZEK, A., AGOSTI, D., ALONSO-ZARAZAGA, M., BECCALONI, G., de PLACE BJØRN, P., BOUCHET, P., BROTHERS, D. J., EVENHUIS, N., GODFRAY, H. C. J., JOHNSON, N. F., KRELL, F.-T., LIPSCOMB, D., LYAL, C. H. C., MACE, G. M., MAWATARI, S., MILLER, S. E., MINELLI, A., MORRIS, S., NG, P. K. L., PATTERSON, D. J., HOLE, W., PYLE, R. L., ROBINSON, N., ROGO, L., TAVERNE, J., THOMPSON, F. C., van TOL, J., WHEELER, Q. D., WILSON, E. O., 2005. A universal register for animal names. *Nature*, **437**, 22 September 2005: 477.
- SCHOCH, R. M., 1986. *Phylogeny Reconstruction in Palaeontology*. Van Nostrand Reinhold, New York, i–xii+1–353.
- SCHUH, R. T., 2000. *Biological Systematics: Principles and Applications*. Cornell University press, New York. i–ix+1–236+[3].
- SEBERG, O., HUMPHRIES, C. J., KNAPP, S., STEVENSON, D. W., PETERSEN, G., SCHARFF, N., ANDERSEN, N. M., 2003. Shortcuts in systematics? A commentary on DNA-based taxonomy. *Trends in Ecology and Evolution*, **18**(2): 63–65.
- TAUTZ, D., ARCTANDER, P., MINELLI, A., THOMAS, R. H., VOGLER, A. P. 2003. A plea for DNA taxonomy. *Trends in Ecology and Evolution*, **18**(2): 70–74.
- WHEELER, Q. D., 2004. Taxonomic triage and the poverty of phylogeny. *Philosophical Transactions of the Royal Society of London*, **B**, **359**: 571–583.
- WHEELER, Q. D., RAVEN, P., WILSON, E. O., 2004. Taxonomy: impediment or expedient? *Science*, **303**: 285.
- WHEELER, Q. D., VALDECASAS, A. G., 2005. The challenges to transform taxonomy. *Graellsia*, **61**(2): 151–160.

- WILSON, E. O., 1989. The current coming pluralization of biology and the stewardship of systematics. *BioScience*, **39**: 242–245.
- , 2004. Taxonomy as a fundamental discipline. *Philosophical Transactions of the Royal Society of London, B*, **359**: 739.
- WINSTON, J. E., 1999. *Describing Species. Practical taxonomic procedure for taxonomist*. Columbia University Press, New York. i–xx+1–518.
- WOODCOCK, B. A., 2002. The importance of taxonomy in ecology. *Antenna*, **26**(1): 18–21.
- YOUNG, A. M., 2004. Taxonomy and natural history. *Science*, **305**: 1107.
- ZHANG, Z.-Q., 2006a. The first five years. *Zootaxa*, **1111**: 68.
- , 2006b. The making of a mega-journal in taxonomy. *Zootaxa*, **1385**: 67–68.
- , 2007. A forum for the discussion of issues in zoological taxonomy. *Zootaxa*, **1407**: 1–2.