

Scientific Report - February 2008

A network of scientists under the umbrella of 'Assembling the Tree of Life in Europe (AToLE)' seeks funding under the FP7-Theme: Cooperation - Environment (including Climate Change and Biodiversity Conservation) programme of the European Commission

Global Change in an Evolutionary Context: Using Phylogeny to Predict the Future of Europe's Biodiversity

List of participants:

Dr. Olaf R.P. Bininda-Emonds, University of Oldenburg (Germany)

Dr. Wieslaw Bogdanowicz, Museum and Institute of Zoology PAS (Poland)

Dr. Thomas Borsch, Botanischer Garten und Botanisches Museum Berlin-Dahlem, Freie Universität Berlin (Germany)

Dr. Frédéric Delsuc, CNRS-Université Montpellier II (France)

Dr. Alexandre Hassanin, Muséum national d'Histoire naturelle (France)

Dr. Ulf Jondelius, Swedish Museum of Natural History (Sweden)

Dr. Gitte Petersen, Botanical Garden and Museum, University of Copenhagen (Denmark)

Dr. Susanne S. Renner, University of Munich (Germany)

Dr. Vincent Savolainen, Imperial College London and Royal Botanic Gardens Kew (UK)

Dr. Ole Seberg, Botanical Garden and Museum, University of Copenhagen (Denmark)

Dr. Erik Smets, National Herbarium of the Netherlands, Leiden University (Netherlands) and K.U.Leuven (Belgium)

Dr. Alfried P. Vogler, Imperial College London and Natural History Museum (UK)

Following the Expression of Interest (Eoi) sent to the European Commission in 2002 (encl.) and numerous subsequent meetings (Kew, London, Brussels, Bergen, among others), an informal delegation of AToLE met in Warsaw (Museum and Institute of Zoology PAS) on 13 January 2009. The dual aim of this meeting was: (i) to re-define our research strategy to line-up with current priorities in the European Research Area (ERA), and (ii) to initiate lobbying efforts to the FP7-Cooperation for Environment programme that already has listed "Contribution to assembling the tree of life" as a tentative topic for a future call.

The AToLE initiative is - more than ever – highly relevant to broad scientific and societal needs, and indeed to the priorities of FP7's Environment Programme. At the

time of our original EoL, the study of the Tree of Life was limited by expensive and slow DNA sequencing technology and insufficient bioinformatic tools. Rapid progress in these areas is placing 'the Tree' increasingly within our reach, thereby laying the foundation for a better integration of the Tree of Life with wider questions about the origin of biodiversity and its projected future in a changing world. Our growing capacity to massively scale up the study of the Tree of Life now permits dense species and population sampling, including complete species assemblages, while obtaining ever greater proportions of their genomes. Two new science disciplines have emerged in the post-genomic era in which the Tree of Life has a pivotal role to play:

1. **Ecological & Community Phylogenetics**: An evolutionary context is needed to understand how Europe's biodiversity originated and how the composition of its ecosystems changed, and what threats its species face. It has also been shown that key aspects, including speciation rates, extinction risks, and dispersal abilities have strong evolutionary constraints. Therefore, predicting future changes in biodiversity at the species- or ecosystem-level will depend on an in-depth understanding of how European biotic diversity was generated over time and how it is maintained. This will require an integration of ecological, climatic, and phylogenetic knowledge.
2. **Biodiversity Genomics**: New ultra-high-throughput DNA sequencing technologies (e.g., 454, Solexa, SOLiD) are now available so that entire genomes can be sequenced more quickly and cheaply than ever. The previous generation of Tree of Life studies has focused on the targeted sequencing of a limited number of genes across phylogenetic lineages, but our new ability to sequence entire communities using 'metagenomics' and PCR-based approaches now permits studying the composition and geographic distribution of the living world in much greater depth. Use of these 'next-generation' DNA sequencing technologies will place AToLE even more firmly into the post-genomics era.

These technological developments will enable us to address two European-specific issues that have remained unresolved, in part because of the lack of a dedicated, comprehensive research program, and which would benefit tremendously from AToLE:

1. **Europe's biodiversity is still poorly known**: Despite the long systematic tradition in Europe and the historical focus on European biodiversity, a large fraction of European diversity remains unknown, with a large number of new species being discovered continuously, even in supposedly well-known groups, such as insects¹. Routine

¹ The recent Swedish Malaise trap project has yielded more than 500 insect species new to science, and the total size of insect fauna in Sweden has been adjusted from ~ 25.000 to 31.000 species.

species identification remains equally problematic, and may be improved through the application of DNA barcoding, which may also help flag yet undiscovered species. Surprisingly little is known about the evolutionary relationships of the vast majority of species in Europe, including that of charismatic groups such as birds and butterflies. Species diversity in Europe is huge and therefore only subsets can be analysed, but a robust and densely sampled tree for key groups will establish fundamental biodiversity parameters of broad interest in the ERA.

2. **A large portion of Europe's biodiversity is highly threatened**: Europe's flora and fauna has originated from complex historical interactions involving biotic and abiotic factors that have shaped the distribution of genetic variation across Europe. A large proportion of this biodiversity is currently threatened by global change and/or anthropogenic activities. Because the exact impact of these factors tend to be taxon-specific, predictive models of future range contractions, extinction, invasiveness and other parameters of change across the Tree require model groups that represent different evolutionary histories.

Existing EU initiatives have created valuable tools for electronic inventories of taxonomic entities (e.g., EDIT), which present the logical starting point to build upon to achieve an evolutionary synthesis of Europe's biodiversity.

Therefore, we propose that the following specific topics are included in FP7 call under Cooperation - Environment (including Climate Change and Biodiversity Conservation):

- **Reconstruction of the Tree of Life (phylogeny) of European biodiversity at the level of taxa and genomes.** Continuing phylogenetic research will greatly expand existing data both in the density of sampling and in the depth of genomic coverage. Analytical bottlenecks from the use of voluminous genomic data will require new bioinformatic methods for sequence data manipulation and storage, tree searches, and tree visualisation. The focus on European taxa will need to link with initiatives elsewhere to assess the monophyly of specific European lineages and the relative contributions of European lineages to the total phylogenetic diversity (PD) across the Tree of Life. Increasingly, these analyses will aim at comparing partial or complete genomes throughout the Tree of Life, extending the phylogenetic hierarchy to the level of genes. Such a coordinated phylogenomic approach has the potential to correlate genes and genome content with their ecological function (see below).
- **Integration of the European Tree of Life with environmental and genomic data to reveal the origins of European biota.** Understanding the mechanisms of speciation, historical biogeography and historical ecology (including community ecology) will add

significantly to current macro-ecological studies and will help predict the effects of the drastic global changes forecast in the coming decades. Phylogenetically-based research will form a critical component of this research program, given that the information obtained can only be fully interpreted in an evolutionary context. AToLE aims therefore (i) to reconstruct the timing of major inter-changes of European biodiversity and (ii) to estimate how much of European biodiversity has arisen because of *in situ* speciation versus immigration. Many research questions should focus on the radiations of European organisms in response to glaciation events. Glaciations have affected European biodiversity throughout its history and represent one of the few historical examples of severe climate change from which useful insights may be drawn.

- **Predicting and protecting the future of European biodiversity by analysing global change data in an evolutionary context.** The predictive power of integrated ecological and phylogenetic data means that AToLE will also make key contributions to nature conservation. The necessity of protecting the gene pools of species and evolutionary diversity in the Tree has long been recognised. Conservation genomics will identify taxa at the greatest risk of future extinction by identifying the genetic basis of traits relevant to the response to environmental change, pollution and shifts in the composition of communities. Moreover, evolutionarily isolated taxa that harbour large amounts of unique genetic diversity can also be identified and targeted for conservation action as needed.

The threats facing biodiversity today are historically unprecedented. Effective conservation of this biodiversity in the future required detailed knowledge not only of its current status, but also of how it came to be. An AToLE initiative is uniquely positioned to help deliver the latter information, which when integrated with the other ecological and geographic data to be generated through the FP7 Environment programme, will prove invaluable in protecting European biodiversity into the future.

- Expression of Interest for an Integrated Project under Thematic Priority 1.1.6.3

Assembling the Tree of Life - Europe (ATOL)

Call identifier: EOI.FP6.2002

Date of submission: 6 June 2002

List of Partners:

1. Royal Botanic Gardens, Kew, UK (Vincent Savolainen, Mark Chase, Mike Fay)
2. Imperial College, Univ of London, Ascot, UK (Tim Barraclough, Andy Purvis, Donald Quicke, Austin Burt)
3. The Natural History Museum, London, UK (Alfried Vogler, Mark Wilkinson, Richard Thomas, D.T.J. Littlewood)
4. Dept of Zoology, Univ of Oxford, Oxford, UK (Eddie Holmes, Andrew Rambaut)
5. Univ of Reading, Reading, UK (Mark Pagel, Paul-Michael Agapow, Julie Hawkins)
6. Univ of Glasgow, Glasgow, UK (Rod Page)
7. University Museum of Zoology, Cambridge, UK (Max Telford)
8. Natural History Museum of Geneva, Switzerland (Jean Mariaux)
9. Dept of Zoology, Univ of Geneva, Geneva, Switzerland (Jan Pawlowski)
10. Dept of Botany, Univ of Zurich, Zurich, Switzerland (Peter Linder)
11. Dept of Biology, National Univ of Ireland, Ireland (James McInerney)
12. Dept of Botany, Univ of Dublin, Ireland (Trevor Hodkinson)
13. Botanical Garden – Center for Biodiversity Conservation of the Polish Academy of Sciences, Warsaw, Poland (Piotr Bednarek)
14. Plant Breeding and Acclimatization Institute, Radzików, Poland (Wiesaw Podyma)
15. Univ of Uppsala, Uppsala, Sweden (Kåre Bremer, Fredrik Ronquist, Vincent Moulton, Katharina Huber, Mikael Thollesson)
16. Museum of Natural History, Stockholm, Sweden (Mari Källersjö, Steve Farris)
17. Dept of Evolutionary Botany, Univ of Copenhagen, Denmark (Gitte Petersen, Ole Seberg)
18. Zoological Museum, Univ of Copenhagen, Denmark (Niels Peder Kristensen, Rudolf Meier, Henrik Enghoff, Nikolaj Scharff, Nils Møller Andersen)
19. Zoological Institute, Univ of Copenhagen, Denmark (Jens Høeg, Henrik Glenner)
20. Novozymes A/S, Bagsvaerd, Denmark (Lene Lange)
21. ICAT, Lisboa, Portugal (Helena Cotrim)
22. Natural History Museum, Paris, France (Jean-Pierre Hugot, Simon Tillier, Thierry Bourgoïn)
23. Univ Claude Bernard, Lyon, France (Manolo Gouy, Catherine Hänni)
24. Ecole Normale Supérieure, Lyon, France (Vincent Laudet, Marc Robinson-Rechavi)
25. Univ of Montpellier, Montpellier, France (Olivier Gascuel, Vincent Berry, Emmanuel Douzery)
26. INSERM, Univ of Provence, Marseille, France (Pierre Pontarotti, André Gilles)
27. CIRAD, Montpellier, France (Xavier Perrier)
28. University of Jussieu, Paris, France (David Moreira, Purificación López-García)
29. Institute of Molecular Biology and Medicine, Free Univ of Brussels, Brussels, Belgium (Michel Millinkovitch)
30. National Botanic Garden, Meise, Belgium (Elmar Robbrecht)
31. Dept of Zoology, Univ of Munich, Munich, Germany (Gerhard Haszprunar)
32. Dept. of Animal Sciences, Technical Univ. of Munich, Germany (Olaf Bininda-Emonds)

Expression of Interest

ATOL

EOI.FP6.2002

33. Genetics Institute, Univ of Koeln, Koeln, Germany (Diethard Tautz)
34. Zoological Research Institute and Museum Koenig, Bonn, Germany (Bernhard Misof)
35. German Collection of Microorganisms and Cell Cultures GmbH, Braunschweig, Germany (Erko Stackebrandt,)
36. Univ of Jena, Jena, Germany (Rolf Beutel)
37. Botanisches Museum Berlin-Dahlem, Freie Universität Berlin, Berlin, Germany (Christoph Oberprieler)
38. Palacky Univ, Czech Republic (Milada Bocakova, Ladislav Bocak)
39. Univ of Zaragoza, Spain (Pilar Catalan)
40. Natural History Museum, Madrid, Spain (Rafael Zardoya)
41. Dept of evolutionary biology, Univ of Siena, Siena, Italy (Francesco Frati)
42. Univ of Roma 2, Roma, Italy (Valerio Sbordoni)
43. Nationaal Herbarium Nederland, The Netherlands (Pieter Baas, Barbara Gravendeel, Lars Chatrou, Freek Bakker)
44. CBS. Fungal Biodiversity Center, Utrecht, The Netherlands (Dirk Van der Mei & Joost Stalpers, Pedro Crous)
45. Zoological Museum, Amsterdam, The Netherlands (Wouter Los)

1. Need and Relevance

Assembling the Tree of Life (the phylogeny of all organisms; ToL) is a priority for describing and understanding biodiversity and its broad exploitation for human purposes. Biodiversity affects our lives at numerous levels: (i) natural world providing resources, agriculture, water management, eco-tourism; (ii) understanding and exploiting diversity at functional and genomic levels; and (iii) understanding the spread of disease agents and vectors. **A comprehensive ToL is essential for a predictive understanding of biodiversity and tightly linked to successful expansion of post-genomic knowledge.** Piecemeal systematic projects cannot achieve this aim; we need a major integrated effort to obtain data and tools needed for a comprehensive, world-leading resource.

We propose a bold collaboration bringing together diverse expertise in phylogenetic theory, software development, molecular systematics and taxonomic knowledge so that ToL knowledge is made available to end-users in an integrated manner. The ToL will become the ultimate taxonomic reference. **The objectives of Thematic priority 1.1.6.3 Biodiversity and Ecosystems can only be met if there is a solid platform on which to base the risk assessments of biodiversity and the understanding of ecosystems.**

Europe has abundant expertise in these areas, but an integrated approach is now needed: (i) to spread expertise among institutions, (ii) to co-ordinate research toward integrated goals for targeted end-users, and (iii) to produce vital hardware and software that enable data collection and analysis on an ambitious scale across Europe (e.g., via grid supercomputing).

Phylogenetics has been revolutionised by molecular methods and statistical analysis. DNA sequences are now routinely and successfully used to reconstruct trees, leading to a database of molecular phylogenetic information that is growing at an ever-increasing rate. Phylogenetic approaches underpin modern biological research.

GENOMICS * large-scale genome changes and their effects on function

* genomic diversity across life as a whole, the new field of phylogenomics

* detecting the action of natural selection across genomes

* EvoDevo: understanding the diversity of developmental mechanisms

BIODIVERSITY * predicting functional diversity within ecosystems and communities

* evolution of biodiversity, speciation and adaptive radiation

* setting priorities for species conservation, reserve locations, and identifying extinction risks

* targeting biological control of invasive species and understanding pest-host evolution.

HEALTH * informed bioprospecting for pharmaceutical and agrochemical products
* tracking the origin and spread of diseases and their vectors, disease-host coevolution
* the evolution of DNA transposable elements and risk factors for GMOs

Molecular methods and DNA sequencing technology are now sufficiently advanced to make a concerted assault on the ToL. **The key challenge is to integrate data collection on a massive scale**, filling in major gaps, e.g. single-celled eukaryotes and microbes, and producing detailed data for a full range of potential applications. In addition, methods for phylogenetic analysis were typically developed with much smaller tasks in mind. **A vital step towards the ToL is development of new methods, software and strategies (e.g. parallel computing) for analysing large matrices and integrating data into a single resource.**

2. Scale of ambition and critical mass

The aim of ATOL will be to produce a world-leading European phylogenetic resource as a tool for biodiversity research and management.

Specific scientific objectives:

- ***Phylogenetic framework: all organisms in Europe, from natives to collections.*** As a framework for more detailed studies, ATOL will generate phylogenetic data for all higher groups of European organisms, including natives and those found in the major biodiversity collections. **The aim is to obtain complete representation for a global ToL, at least at the taxonomic level of the family but mostly in more detail depending on the taxon in question.** By focusing on Europe and its collections (museums, seed banks etc), the results will have maximum potential, by virtue of the massive amount of information that already exists for European organisms in terms of ecology, genetics, conservation status etc. We will co-ordinate sampling strategy with ToL projects in the USA and elsewhere.
- ***Detailed phylogenetic studies for organisms with a major impact on human society and/or role in the environment.*** Target groups include beetles, parasitic wasps, flies, mites (diverse components of terrestrial ecosystems, agricultural pests, biocontrol), monocots (comparative crop genomics and drylands), fish, mammals, birds (conservation), worms (soil and parasites), bacteria, viruses, and yeasts (ecosystem processes, disease and food safety). These will be sampled intensively and comprehensively. **We will develop new tools for specific uses, such as databasing and DNA-identification, forensics, marker assisted artificial selection.** This objective would take advantage of existing taxonomic networks and links with USA but focus on EU issues and taxa.

- **Gap-filling for poorly known organisms.** We will generate phylogenetic data for poorly known groups of organisms for which there is strong European taxonomic expertise. Target groups include protozoa, soil fungi, rotifers, parasitic crustaceans, urochordates, frogs, etc. all groups with dominant roles in ecosystems (including marine) but which are little studied. For example amoeboid protists are among the most abundant free-living microbial eukaryotes in terrestrial and aquatic ecosystems, playing a key role in nutrient cycling, but their diversity and phylogenetic relationships remain poorly known.
- **Analytical tools for ToL and user interface.** We will develop new methods and software for analysing large DNA matrices, genome-level data at a phylogenetic level (phylogenomics), and supertree approaches for combining data sets into a single ToL. **We will adopt a new conceptual approach, utilising computer networks for parallel computing. We will develop web-based resources for submitting, compiling and disseminating ToL information,** linked to major taxonomic collections, gene banks (EMBL), and other ToL-oriented web sites.
- **ATOL as a resource for biological research.** ATOL members will use the new data for a wide range of research applications. Key areas will include the function and evolution of diversity in ecosystems, phylogenomics, and the evolution of development (EvoDevo).
- **SMEs: bioprospecting, impact assessment, health care.** We will target SMEs as end-users, especially companies processing ToL-related information for applied use.

These objectives are timely and critical to European research in pure and applied biodiversity studies. Modern molecular technology and computer power now makes this an achievable aim, but the methods need scaling up. **Europe has played a leading role in this area but needs a major thrust to compete and collaborate with current USA initiatives, such as the 15-year NSF programme on Assembling the Tree of Life.** Global collaboration will be essential for the formidable task of assembling a ToL.

Europe has world-class expertise in the theory and practise of phylogenetics, with many major taxonomic and biodiversity institutions. ATOL would take advantage of existing networks; it will bring together wide expertise, and researchers working on a wide range of organisms. **The onrush of the post-genomic age and primacy of environmental issues and emerging diseases make phylogenetics a central requirement for society.**

3. Description of Challenges and Scientific Strategy

Our challenges are to sample a significant portion of the Earth biodiversity in a clearly prioritised way, to produce massive phylogenetic data (mostly molecular) and new bioinformatics tools so that a large portion of the ToL can be assembled.

The ToL must have a predictive value, increase our knowledge in biology and medicine, and be particularly relevant to ecosystems and disease management. It must facilitate emerging scientific disciplines, and become a foundation for all life sciences.

- **Intensive sampling.** Target groups will be sampled from the field and from the immense collections (literally several billions of organisms) held by European museums, botanical gardens, and seed/tissue banks. Taxonomic expertise across Europe has built up over centuries and this guarantees the success of this initial phase of ATOL.
- **Data production.** ATOL will focus on assembling DNA sequence data. Existing sequences will be extracted from EMBL, but clearly massive data production is required for ATOL. **Targeted genes, genomes (plastid or mitochondrial), or nuclear loci (provided by cDNA libraries) will be sequenced by the participating teams, taking advantage of detailed genomic knowledge from model organisms.** Molecular expertise and infrastructure is considerable across the teams so there is no significant risk associated with this phase of ATOL. We will also compile data on morphology and fossils into a morphobank, vital sources of independent data and for dating with molecular clocks.
- **Bioinformatics.** Developing bioinformatics tools appropriate to the scale of ATOL is the most challenging part of our project. Current methods and software are unable to deal with very large data sets that will result from ATOL. **ATOL will develop new approaches for analysing large data matrices, including development of new heuristics and search algorithms, development of new frameworks for analysis e.g. Bayesian methods, and use of networked parallel computing.** Another key challenge is to combine trees obtained for different groups and DNA regions into a single estimate of the ToL, so-called supertree analysis. Supertrees have been reconstructed for a wide range of taxonomic groups, including parasitic worms, birds, mammals and plants. **ATOL will design algorithms for large-scale supertree reconstruction, implemented in a 'live' on-line application for submission and retrieval of phylogenetic information.** Expertise in bioinformatics is excellent and members of ATOL have written hundreds of phylogenetic applications. What is needed is to scale up these approaches and to integrate them in a user-friendly manner. One risk is the high computational demand needed for tree searching; we will explore radical approaches for optimizing computer resources across the network.

- ***Use as predictive tool.*** Use of phylogenetics in biological research has exploded over the last decade, leading to greater predictive power and statistical rigour for comparative biology. Theory for the statistical analysis of biological diversity on phylogenetic trees is extensive. **A key challenge for ATOL will be to foster use of the vastly increased potential offered by ToL-scale data.** We will develop new tools for phylogenetic analysis, particularly in phylogenomics, biodiversity, disease evolution, and EvoDevo.

4. Integrated Activities

The ATOL programme will focus on data production for targeted groups of organisms and the development of software for building and analysing the ToL. A major component will be providing advanced training at both pre- and postdoctoral levels. Teams will produce new data for each target group of organisms, and identify specific analytical challenges that require concerted and integrated effort. A team of about 10 bioinformatics scientists will work on developing the necessary software, including a core team located centrally, linked to computer experts and to the major bioinformatics and genomic centres in Europe (e.g. EBI/EMBL), and additional members interacting on a day-to-day basis with the biologist teams.

Building on biotechnological and advanced computer resources, ATOL will train approximately 80 young scientists recruited across Europe. There is a clearly uneven distribution of phylogenetic activities across Europe and special attention will be given to allocating resources to countries with expertise but fewer resources to conduct ToL research. The development of open web-based tools for accessing, analysing and utilising ATOL information will also contribute to making ATOL benefits available throughout Europe.

ATOL has such a broad scope that it is multidisciplinary in essence. Biological specialists must be involved in sample collection. Advanced biotechnology is required to achieve massive molecular data production. Bioinformatics, phylogenomic, mathematical and biological experts must be involved in the analytical phases before finished products can be delivered to the broader scientific community (ecology, medicine, etc.) and other end-users in society including SMEs (ecosystem managers, conservationists, pharmacologists, bioprospectors etc).

Computing resources will be concentrated on one site and provide a bioinformatics platform where members of the teams will work for 3-6-month periods of time. The aim will be to provide a core network accessible by all members of ATOL and optimising computer resources across participating institutions. Communication among the teams will be facilitated by an intranet web site and meetings. An external web site will enhance networking across the world.

Dissemination. ATOL will be very pro-active in disseminating its results and tools through available means and particular attention will be given to free electronic dissemination.

Management. There will be a Project Steering Group made up of core members working with the scientific co-ordinator and a full time project co-ordinator.

Budget: 30 MEURO over four years.

Overview of leading industrial and academic research centres and other major participants
(Gov=Government; Univ=University)

Partner	Type	Expertise	Role (with indication of team leaders)
Royal Botanic Gardens, Kew, UK	Gov	Botany	Assemble plant trees (Vincent Savolainen, Mark Chase, Mike Fay)
Imperial College, Univ of London, Ascot, UK	Univ	Evolutionary biology, bioinformatics	Comparative analyses and trees (Tim Barraclough, Andy Purvis, Donald Quicke, Austin Burt)
The Natural History Museum, London, UK	Gov	Bioinformatics, zoology	Assemble animal trees, supertree (Alfried Vogler, Mark Wilkinson, Richard Thomas, D.T.J. Littlewood)
Dept of Zoology, Univ of Oxford, UK	Univ	Bioinformatics	Assemble bacterial and viral trees, software (Eddie Holmes, Andrew Rambaut)
Univ of Reading, UK	Univ	Bioinformatics,	Develop new bioinformatic tools (Mark Pagel, Paul-Michael Agapow, Julie Hawkins)
Univ of Glasgow, UK	Univ	Bioinformatics	Develop new bioinformatic tools (Rod Page)
Univ Cambridge, UK	Univ	Zoology	Assemble animal trees (Max Telford)
Natural History Museum, Switzerland	Gov	Zoology	Assemble trees for parasitic worms (Jean Mariaux)
Dept of Zoology, Univ of Geneva, Switzerland	Univ	Zoology	Assemble trees for free-living protists (Jan Pawlowski)
Univ of Zurich, Switzerland	Univ	Botany	Assemble plant trees (Peter Linder)
National Univ of Ireland, Ireland	Univ	Bioinformatics	Develop software for supertrees (James McInerney)
Dept of Botany, Trinity College, Ireland	Univ	Botany	Assemble trees for grasses (Trevor Hodkinson)
Polish Academy of Sciences, Poland	Gov	Germplasm	Assemble plant trees (Piotr Bednarek)
Plant Breeding Institute, Poland	Gov	Botany	Assemble plant trees (Wiesaw Podyma)
Univ of Uppsala + Museum Stockholm Sweden	Univ	Bioinformatics, biogeography	Assemble trees, algorithms (Bremer, Ronquist, Moulton, Huber, Kallersjo, Farris, Thollesson)
Univ of Copenhagen, Denmark	Univ	Botany	Assemble plant trees (Gitte Petersen, Ole Seberg)
Zoological Museum, Univ. of Copenhagen, Denmark	Univ	Zoology	Assemble Arthropod trees (N. Kristensen, R. Meier, H. Enghoff, N. Scharff, N. Andersen)
Zoological Institute, Denmark	Univ	Zoology	Assemble animal trees (Jens Høeg, Henrik Glenner)
Novozymes A/S, Bagsvaerd, Denmark	SME	Mycology	Assemble fungal trees (Lene Lange)
ICAT, Portugal		Botany	Assemble plant trees (Helena Cotrim)
Natural History Museum, France	Gov	Zoology Paleontology	Assemble animal trees (Jean-Pierre Hugot, Simon Tillier, Thierry Bourgoïn)
Univ Claude Bernard, France	Univ	Bioinformatics	Develop software in molecular evolution (Manolo Gouy, Catherine Hänni)
Ecole Normale Supérieure, France	Acad	Bioinformatics	Assemble animal trees (Vincent Laudet, Marc Robinson-Rechavi)
Univ of Montpellier, France	Univ	Bioinformatics, zoology	Develop algorithms, assemble animal trees (Olivier Gascuel, Vincent Berry, Emmanuel Douzery)
INSERM, Univ of Marseille, France	Gov	Marine Biology	Develop phylogenomics of marine invertebrates (Pierre Pontarotti, André Gilles)
CIRAD, France	Gov	Bioinformatics	Develop supertrees (Xavier Perrier)
University of Jussieu, France	Univ	Bioinformatics, Protistology	Develop new algorithm, Assemble trees for marine protists (David Mareira, Purificación López-García)
Free Univ of Brussels, Belgium	Univ	Bioinformatics	Assemble animal trees (Michel Millinkovitch)
National Botanic Garden, Belgium	Gov	Botany	Assemble plant trees (Elmar Robbrecht)
Univs, Munich, Germany	Univ	Bioinformatics, zoology	Develop supertrees (Olaf Bininda-Emonds, Gerhard Haszprunar)
Genetics Institute, Univ of Koeln, Germany	Univ	Zoology	Assemble animal trees (Diethard Tautz)
Zoological Research Institute, Germany	Gov	Zoology	Assemble arthropod trees (Bernhard Misof)
German Collection of Microorganisms	Gov	Mycology,	Assemble micro-organism trees (Erko

Expression of Interest**ATOL****EOI.FP6.2002**

and Cell Cultures GmbH, Germany		bacteriology	Stackebrandt,)
Univ of Jena, Germany	Univ	Zoology	Assemble arthropod trees (Rolf Beutel)
Botanisches Museum Berlin-Dahlem, Freie Universität Berlin, Germany	Univ	Botany	Assemble plant trees (Thomas Borsch), Biodiversity informatics and databases (Walter Berendsohn)
Palacky Univ, Czech Republic	Univ	Zoology	Animal trees (Milada Bocakova, Ladislav Bocak)
Univ of Zaragoza, Spain	Univ	Botany	Assemble plant trees (Pilar Catalan)
Natural History Museum, Madrid, Spain	Gov	Zoology	Assemble insect trees (Rafael Zardoya)
Univ of Siena, Italy	Univ	Zoology	Assemble arthropod trees (Francesco Frati)
Univ of Roma 2, Italy	Univ	Zoology	Assemble arthropod trees (Valerio Sbordoni)
Nationaal Herbarium Nederland	Gov	Botany	Assemble plant trees (Pieter Baas & coll.)
CBS. Fungal Biodiversity Center, The Netherlands	Gov	Mycology, bacteriology	Assemble micro-organismal trees (Dirk Van der Mei, Joost Stalpers, Pedro Crous)
Zoological Museum, Amsterdam, The Netherlands	Gov	Zoology	Assemble animal trees (Wouter Los)