Outcomes and Recommendations

of the Meeting on

BIODIVERSITY

THE MEGASCIENCE IN FOCUS

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General Introduction

The Brazilian Academy of Science, the Society for the Progress of Science, the International Union of Biological Sciences, and the *Memoria Naturalis* Association (a network of Brazilian natural history museums and affined institutions) were approached by the Brazilian Ministries of the Environment and of Science and Technology to organize a COP8 Associated Meeting to be held in Curitiba, Brazil, 15–19 March 2006.

The aim was to forge stronger links between environmental policy-makers, as represented by the CBD, and the worldwide community of biodiversity scientists, who produce the knowledge on which policy decisions are made.

Both parties are well aware of the need for greater and more effective communication: on the one hand scientists have to understand the requirements of policy-makers and society and the short time-frames in which decisions often have to be made; on the other, those who call for scientific information must appreciate the size and nature of the challenges facing scientists in their efforts to fulfil these demands.

It is also clear that the challenges of biodiversity science, as a true megascience, require an international, multi-centre approach involving collaboration and cooperation at all levels.

The resulting meeting, under the overall title ‘Biodiversity – The Megascience in Focus’, brought together nearly 200 scientists from around the world, as well as a number of policy-makers, in three Workshops:

- Workshop I – Biodiversity and Systematics
- Workshop II – Benefit Sharing and Bioethics
- Workshop III – Sustainability

The participants in each workshop debated the challenges and opportunities of their respective fields, identifying those paths for future work that would most effectively meet society’s requirements. Their conclusions and recommendations, which are presented in greater detail in subsequent sections of this document, may be summarized as follows:

Biodiversity and Systematics

- Our knowledge of biodiversity needs to be greatly expanded by doubling the rate of taxonomic inventories and species discovery and description by 2015.

- This will require a commensurate increase in taxonomic expertise and infrastructure.

- The rapidly developing field of informatics and communications technology must be harnessed both to facilitate scientific work and to disseminate taxonomic products to all users, including the general public.

Benefit Sharing and Bioethics

- Mutual trust, cooperation and communication among all stakeholders – including policy-makers, institutions, scientists, and local communities – are essential if the biodiversity challenges facing us are to be met.

- Access to materials and knowledge should be facilitated for the benefit of all.

Sustainability

- A more predictive and integrative science of biodiversity is needed.

- Performance-based contractual mechanisms for providers of ecological goods and services are required, organized on a regional scale.

- Indigenous and local communities should be involved at all stages in decision-making processes.

- The incorporation of economic instruments to biodiversity conservation in public environmental policies is highly desirable.

Report from Workshop I – Biodiversity and Systematics

Introduction

Achieving the overall goals of the CBD, especially the GTI programme of work (UNEP/CBD/COP/6/20/VI/8) as well as the 2010 biodiversity targets, requires sound knowledge of how many species there are, where they live, and how they are related to one another. This knowledge is provided by the field of taxonomy – more broadly termed systematics.

The taxonomic community also provides both the means to identify species reliably and the stewardship of the natural history collections that house the material basis upon which our knowledge of biodiversity is built, now and throughout time.

Systematics supplies essential knowledge to the other biodiversity sciences, and it presents a unique and fundamental historical perspective on biodiversity by providing the basis for all comparative biology in the form of a predictive classification system reflecting the tree of life. Awareness of the critical role of taxonomy is increasing on many levels, locally, nationally, and internationally.

To further the key objectives of the Convention to conserve biodiversity, assure its sustainable use, and equitable sharing of benefits and additionally to reduce risks and uncertainties associated with environmental decision-making, an expanded global taxonomic agenda needs to be realized that builds on past achievements. Despite important accomplishments by the Parties and other stakeholders in implementing the programme of work embodied in the Global Taxonomy Initiative (GTI), much remains to be done.

Many exciting taxonomic projects are currently underway, addressing increased efficiency of species discovery and description, enhancing capacity building and human resources, as well as the rapid development of a tree of life. These efforts are scattered, but collectively they provide the beginnings of the comprehensive plan of global research we envision.

This also is an exceptional moment from the standpoint of the coordination of the taxonomic community, as evidenced by the great successes of GBIF and many other regional and global informatics initiatives. In short, we have a unique opportunity to dramatically increase taxonomic knowledge, make it more broadly accessible, and then apply it in innovative ways to realize the goals of the CBD.

Achievements

Over the past decade the taxonomic community has demonstrated the capacity to respond to the needs articulated by the CBD, as well as to contribute significantly to human well-being and livelihood. Examples of key taxonomic achievements and their far-reaching benefits include:

1. Capturing and disseminating information associated with millions of specimens and observations from collections around the world. This has enabled:

- access to these data by countries of origin, thereby contributing to baseline documentation of national biodiversity.
- enhanced understanding of past, present, and potential species distribution, facilitating modeling of ecosystem structure, function and change.
- assessment of biodiversity status in previously surveyed/sampled ecosystems that have been modified by human activities.
- creation of enhanced resources for environmental education at local, national and regional level.
- expanded education about, and access to, biodiversity conservation through field guides of all kinds, public programming, and other media.

2. Providing an outline of the tree of life (plotting the relationships of all organisms), which is beginning to establish a robust predictive framework for the comparative analysis of biodiversity information. This has enabled:

- effective biological control of invasive species and of economically important pests through an improved understanding of the relationships of their hosts and their geographic origins.
- the widespread use of comparative genomic and developmental data to advance human health by identifying emerging diseases, tracing their spread, predicting disease outbreaks and the identity of hosts, and engineering new vaccines.
- design of protected area networks located to maximally offset the effects of biodiversity loss and to conserve evolutionarily distinct lineages at all taxonomic levels.

3. Development of innovative new tools for discovering, managing and interpreting biodiversity data. This has enabled:

- rapid identification of incomplete or fragmentary material facilitating medical research and proactive healthcare, forensic investigations, biosecure borders (such as regulation of trade of protected species, invasive species, emerging diseases).

- development of new identification tools that have accelerated species discovery and description, and provided strong support for ecological monitoring and the management of natural resources.

- an acceleration in the objective assessment of the conservation status of species and increased clarity as to conservation priorities.

- an integration of distributional, genealogical and environmental data to provide more robust surrogates of biodiversity, facilitating measurement of progress towards the 2010 biodiversity target.

- the development of more efficient tools for constructing the tree of life, thus contributing to many areas of human health and the comparative sciences.

The above successes have been made possible through unprecedented international cooperation among taxonomists from a range of research and collections-based institutions, including museums and herbaria, universities, botanical gardens and biological resource collections.

Moreover, there has been an international willingness to develop and adopt shared standards for the capture, transmission and use of taxonomic data, a key focus being to identify priorities of direct relevance to conservation and sustainable use.

Taking Advantage of Opportunities: An Agenda for the Future

The international community of taxonomists recognizes an unprecedented set of opportunities to advance biological systematics in unparalleled ways for two synergistic reasons. First, a significant increase over the last decade of taxonomic science has taken place, involving species discovery, expanded knowledge about their distributions within Earth's ecosystems, the building of collections on a global scale, the increased dissemination of the information associated with those specimens, as well as the understanding of the tree of life. Second, advances in information science, cyber-infrastructure, and a host of new tools for environmental modelling and problem-solving using specimen-based data are also emerging.

By taking advantage of these new opportunities, systematics will create vast new knowledge and will accelerate the distribution of taxonomic capacity worldwide, thereby meeting numerous goals set by the CBD and contributing importantly to human well-being. To realize these scientific objectives and societal needs, the Workshop makes the following 10 recommendations.

Taxonomic Inventory and Capacity Building

Seven of these recommendations pertain to taxonomic inventories at global, regional, and national scales.

Recommendation 1. Double the rate of taxonomic inventories globally by 2015, prioritized to fill in gaps in our knowledge.

Recommendation 2. Double the annual global rate of new species discovery and descriptions to 50,000/year by 2015, and 100,000/year by 2020.

Recommendation 3. Double the rate of national inventories, taking full advantage of the expertise and specimen-based material at regional and global levels.

Recommendation 4. Increase taxonomic expertise and work-force by educating and employing 10,000 additional taxonomists by 2020.

Recommendation 5. Double the capacity and support facilities of taxonomic collections by 2020, including local and regional specimen-based institutions, especially in mega-diverse regions of the world.

Recommendation 6. Significantly expand information flow among collections-based institutions and scientists through wider distribution of broadband Internet access and other appropriate information tools, which are most urgently needed in the smaller and regional institutions.

Recommendation 7. Scale-up biological inventory networks at national, regional and global levels. These networks could be organized at taxonomic levels or at ecological levels involving marine, freshwater, or terrestrial ecosystems.

These recommendations set near-term objectives for significantly increasing our biological inventory effort and capacity. All of these recommendations are highly interdependent, and therefore a meaningful scaling-up of inventory activities requires a parallel increase in collection-based infrastructure and human resources, including professional systematic biologists and collection-support personnel.

Importantly, the expanded professional training envisioned here will place professional scientists not only in collection-based institutions but in many areas of the workforce as well, including environmental management, commercial, health, and public service sectors.

The Workshop concludes that if we are to make significant advances in understanding the quantity of global biodiversity, a major effort must be made to increase the rate of our inventory activity. The above recommendations are designed to increase the current rate of inventory two-fold by 2015 and four-fold by 2020 through increased capacity and human resources as well as by technological advances that are beginning to emerge.

All of these recommendations require international coordination and collaboration in order to reduce redundancies of effort, increase efficiency, and enhance cost-effectiveness. Taxonomists agree that in order to advance knowledge regionally, nationally, and globally, scientists, specimens, and taxonomic information of all kinds must move freely among nations so that benefits can be realized at all levels.

It is especially important to facilitate the flow of taxonomic information and expertise from the countries housing megadiverse collections to institutions and scientists

worldwide. In addition, if the goals of the CBD to inventory life's diversity are to be realized, efforts should be made to facilitate non-commercial scientific collecting in order to address the taxonomic impediment.

A Tree of Life Informatics Infrastructure

A key identified priority for the GTI is developing national capacity to properly inventory and classify biological diversity (UNEP/CBD/COP/6/20/VI8), which is an important element promoting the sustainable use of biodiversity. Both activities — identification and classification — are based on an extensive understanding of the tree of life (phylogenetic relationships). Furthermore, the GTI programme of work calls for the establishment of a global taxonomic information system that would integrate the multiple ongoing efforts, including those of tree of life research.

Such an effort could scarcely have been realized two years ago. Today, however, with advances in phylogenetic research and informatics, as well as ongoing advances in cyber-infrastructure, we are poised to provide a synthetic framework for the GTI objectives to inventory, classify, and manage biodiversity information.

Recommendation 8. An informatics infrastructure should be developed in order to synthesize and organize knowledge across all biodiversity sciences and place that knowledge within a comparative, predictive framework based on phylogenetic relationships expressed by the tree of life.

Systematic biologists in many countries have recognized the need to unite the knowledge about phylogenetic relationships that is being generated by tree of life research with powerful informatics tools that can use those hierarchical relationships to query, organize and distribute biodiversity information in entirely new ways. Such an infrastructure would create new science and build on other ongoing international efforts; in particular, it would interface and support GBIF in synergistic ways. Phylogenetic informatics will be a new research tool that will enable searches among all kinds of biodiversity information by initiating queries, not using species names as is presently the norm, but using groups of related species, thereby retrieving comparative information about them.

The ability to use the taxonomic hierarchy, or classification, to search specimen collections as well as ecological, genomic, land use, economic, and other environmental databases synergistically will be of immense value in promoting the science of biodiversity and the goals of the CBD.

Education and Outreach to all Stakeholders

The scientific agenda described above will significantly increase the ability of the systematics community to deliver increased information to a broad user community.

Recommendation 9. New interactive tools that make use of current and emerging information and communication technologies should be developed for rapid and accurate species identification and monitoring to meet the needs of society, including resource management, biosecurity, regulation of trade, agriculture and fisheries, public health, and the general public.

Recommendation 10. Significant additional resources should be devoted specifically by collections-based institutions and the larger systematic community to increase public outreach on biodiversity science, conservation, and sustainability.

Systematics and Society

If these goals are met by mobilizing the required investments and resources, the resulting new science, increased taxonomic capacities, and the substantial benefits to society will provide the much needed means for all countries and stakeholders to enable a new, scientifically sound and comprehensive basis for conserving, using, and managing biodiversity at all levels. Achieving these goals will not only empower Parties to implement the objectives of the CBD, but will also increase the science capacity of nations in significant ways.

Integrating taxonomic data with ecological, global change, human impact and other data sources is essential for confronting changes to biological diversity and its conservation and sustainable use. The ability to compare data among Earth's species is crucial for integrating and understanding the full complexity of life. Ecosystems as a whole, and species within them, provide important services to human well-being, often in ways that are understood only when they are lost.

The recovery, remediation and restoration of such services, as well as ensuring that all the other benefits from biodiversity flow to people, will depend directly on the implementation of the recommendations outlined in this agenda.

Report from Workshop II – Benefit Sharing and Bioethics

Introduction

The participants of the COP8 associated meeting "Biodiversity – the Megascience in focus" recognize the need for the further development of the Access and Benefit Sharing (ABS) process, and point out that there is complementarity rather than conflict between global research (e.g. GTI) and CBD goals.

Basic biological research is seriously hampered by many of the current national ABS regulations.

Biodiversity-related research includes (i) non-remunerative research that might be pure biodiversity-related research (taxonomic studies) or applied biodiversity-related research (mostly ecological and ecosystem services studies), (ii) research aiming at developing genetic/biological resources into saleable and thus financially remunerative products (patents, etc.).

Differences between commercial and non-commercial research are still incompletely considered by the Access regulations and procedures but clear delimitations could be defined.

Present situation

Basic biological sciences suffer particularly from the uncertainties of ABS, as no commercial benefits can be offered and basic biological sciences lack the necessary administrative and legal capacities to go through a complex access procedure.

Distrust, rather than trust, is presently dominating the situation in many countries, hampering biological research. This holds for national as well as international research.

Capacity building and long-term research cooperation are recognized as important aspects of ABS, although they are often hampered by the short lifetime of research projects.

Recommendations by 2010

Recommendation 11. There is a need to build and maintain trust with partners and governments as well as to facilitate exchange of specimens and information. Scientists and policymakers need to engage in informed communication and practical cooperation to meet the objectives of the CBD.

Recommendation 12. All countries are encouraged to review their processes for permits on research, collection, import, and export of specimens to rationalize and streamline the ABS process. In addition, rules and regulations need to be practicable.

Recommendation 13. The role of scientists in the evaluation of research proposals by national authorities must be strengthened.

Recommendation 14. Better information for the scientific community about the aims, regulations, and best practice relating to ABS is necessary in both user and provider countries.

Recommendation 15. Scientists must follow best practice in conducting basic and applied biological research recognising bioethical concerns.

Recommendation 16. Scientists are encouraged to engage with research institutions and with indigenous and local communities in capacity building.

Recommendation 17. All countries are encouraged to ensure that measures are taken against the illicit use of genetic resources within their jurisdiction, regardless of whether biological resources are acquired directly in a provider country or from an intermediary, thus reducing restrictions on basic research.

Recommendation 18. From a bioethical perspective biodiversity has a planetary dimension. It follows as a minimum requirement that biodiversity information must be universally accessible.

Recommendation 19. For non-commercial research projects the regulation of access to materials, available knowledge, including literature, must be facilitated on the basis of scientific collaboration to the mutual benefit of all parties. We recommend that regulations (measures, provisions, agreements, etc.) be set up for non-commercial basic biological science projects, whereby designated scientific institutions are authorized to exchange material with each other.

Report from Workshop III – Sustainability

A. Human Dimensions of Biodiversity

Introduction

Biodiversity benefits people through more than just its contribution to material welfare and livelihoods. Biodiversity contributes to security, resiliency, social relations, health, and freedom of choice and action.

Greater progress towards biodiversity conservation, the improvement of human well-being, and poverty reduction will require strengthening response options designed with the conservation and sustainable use of biodiversity and ecosystem services as a primary goal.

The role of science is to help ensure that decisions are made on the basis of the best information available; but ultimately the future of biodiversity must be determined by society.

Key Questions

Three sets of questions urgently need to be addressed:

- What major changes are human activities causing in global and local biological diversity?
- What are the consequences of these changes for humans?
- What are (or should be) society's responses to biodiversity changes?

Finding answers to these questions will require a fuller understanding of the causes and consequences of deforestation, the decline in fisheries, the impact of changes in biodiversity on indigenous peoples and the rural poor, and the loss of traditional ecological knowledge.

Human biodiversity itself – including genetic, phenotypic, and cultural aspects – is also an important research target, since humans are transformative elements of the environment.

The changing human perceptions of biodiversity and the complex interactive dynamics between human diversity and the environment are essential research gaps.

Integrative Science Approaches

Recommendation 20. In order to contribute fully to biodiversity conservation and human well-being, we need to develop a more predictive and *integrative science of biodiversity*.

This should include both responsiveness to social needs in the choice of research directions and, importantly, improved feedbacks into the social policy-making process.

Recommendation 21. A global programme of research and action on the interface of human activities with biodiversity is urgently needed. To date, research has been limited by divergent and non-comparable methodologies, restricting our ability to generalize findings.

We need a coordinated programme of research, starting from a unified set of conceptual bases, employing comparable methods, and supported by a global network of collaborative institutions. This will permit rapid strides toward the development of a truly comprehensive, integrative and functional approach toward biodiversity conservation worldwide.

In many areas of the world, weaknesses in human and social capital are presently the most significant constraints on the protection of biodiversity.

Recommendation 22. Conservation efforts will often need to focus on an integrated set of mutually-reinforcing, parallel objectives, including capacity-building, education, and institutional infrastructure, in order to attain conservation goals and maintain them over the medium to long term.

Outcome-based programmes

Contractual schemes should not be excluded as goals from such areas, but they will need to be elements of integrated approaches.

Because of their ecological and social efficiency, outcome-based programmes for the enhancement of biodiversity need to be developed and applied.

Recommendation 23. An important goal is to work out contractual mechanisms by which providers of ecological goods and services can be remunerated for defined performance standards, rather than simply for management according to specified management frameworks.

Recommendation 24. Payment schemes for the enhancement and production of biodiversity should be organized on a regional scale in order to adjust programmes to specific local and regional conditions.

Among the expected advantages to such outcome-based approaches are the efficient use of local and regional knowledge, greater transparency of decision-making, heightened awareness of biodiversity among the population, and increased motivation to participate in environmental payment schemes.

Indigenous and local communities

Recommendation 25. Indigenous and local communities and regional stakeholders should be involved at every stage of the process of designing and implementing biodiversity-related research and initiatives.

Such participation in decision-making processes about the regional demand for ecological goods and services strengthens feedback between the interests of beneficiaries and producers of biodiversity.

Traditional knowledge

Traditional knowledge should be understood not as a closed corpus, but as an ongoing process of knowledge production by traditional means.

Recommendation 26. Rather than simply preserving traditional knowledge, we need to conserve appropriate conditions for its continued production, which include access to land and resources.

Biodiversity constitutes a stock of genetic and ecological information. Under conditions of rapid global pressure and change, the protection of this information stock will involve attention to the ecological and evolutionary processes by which biodiversity is produced and maintained.

B. Economic Instruments for Biodiversity Conservation

Introduction

This working session was part of the associated meeting "Biodiversity: the Megascience in Focus", focusing Ecological Economic Valuation and Incentives for Biodiversity Conservation. Researchers from the Brazilian Ecological Economics Society, the International Society of Ecological Economics and others research Institutes took part in this event.

Present Situation

There is increasing recognition that humans, like all other living organisms, depend for their well-being and even survival on the services produced by healthy ecosystems. The loss of these services would be catastrophic.

Biodiversity generates many services directly, as well as providing ecosystems with the resilience necessary to recover from the impacts of human activities, thus ensuring the continued provision of these services. There are no known substitutes for many of these services, and little evidence we will be able to develop adequate ones in the future. Even when it is possible to develop human made substitutes for ecosystem services, their provision by healthy ecosystems is generally far more cost effective, and unlike human made substitutes, healthy, biodiverse ecosystems are self sustaining.

Given the state of human knowledge and the complexity of both ecosystems and economic systems, we confront uncertain outcomes and even uncertain facts concerning the present situation. Much of this uncertainty is irreducible. In view of the high stakes we confront, however, decisions are urgent. We need to act quickly on the information we have, striving whenever possible to avoid irreversible outcomes.

While the valuation of ecosystem services can play an important role in generating an awareness of their importance, alone it is generally insufficient to alter behaviour. It is

critical that we go beyond valuation to develop the policies, mechanisms and institutions necessary to protect and restore the ecosystems on which we depend.

A number of economic instruments have been devised and implemented around the world, and have proven successful in a variety of circumstances. Approaches range from charging those who engage in activities that degrade or deplete ecosystem services to rewarding those that contribute to their provision.

Examples of the many economic instruments that have proven successful to date include:

- Brazil's ecological value added tax, which redistributes tax revenue according to conservation criteria.
- Private spending on conservation protection as a compensation/offset of environmental damages associated with investment projects.
- Payments for conserving or increasing native forests because of the ecosystem services provided by them, such as watershed protection, access to genetic resources, climate regulation, tourism and leisure.
- 'Cap and trade' policies which set absolute limits to the amount of pollution or resource extraction allowed to distribute individual quotas which can be traded among polluters or extractors.
- User fees on resource depletion or waste absorption capacity.
- 'Green' taxes on pollution or on the consumption of commodities that degrade the environment.

The volume of payments mobilized by ecosystem markets (e.g. in carbon, biodiversity, and water) is substantial (± $1 billion since inception) but still insignificant compared to the scope of the problem. Even worse, both governments and markets provide perverse incentives – rewards for activities that degrade the environment – totalling hundreds of billions of dollars over the same period.

While there are a number of global environmental agreements, they frequently fail to take advantage of potential synergies. For example, the Kyoto Protocol excludes biodiversity conserving avoidance of deforestation during the first commitment period.

Needs

There is a serious lack of financial resources being dedicated to biodiversity conservation and the provision of ecosystem services. One of our most urgent needs is to generate adequate resources. This requires both a mechanism for collecting the resources as well as the institutions necessary to do so. For example, a tax on gasoline of $0.016/liter would generate $30 billion per year. In reality, this would not be a tax, but rather a user fee for waste absorption capacity. It would also be possible to tax other activities with negative environmental impacts.

While there are numerous economic instruments that have proven successful for providing ecosystem services on the local scale, there are very few in which global beneficiaries of these services pay for the benefits they receive. We need to create both mechanisms and institutions capable of efficiently allocating financial resources towards those who provide ecosystem services. To be efficient, the mechanism must rely on decentralized knowledge (e.g. knowledge of the opportunity costs of changing land use), as the transaction costs of centralizing the necessary knowledge would prove astronomical.

One option would be to adapt Brazil's ecological value added tax on a global scale. This would mean allocating the gasoline tax suggested above (or another source of funding) to different countries in proportion to their success in achieving explicit criteria for conserving biodiversity, defined by the best available knowledge of ecologists, biologists and other appropriate scientists.

The complexity of the problems we face make it impossible to understand them from within the boundaries of any single discipline. We need transdisciplinary approaches to addressing the problems, as well as stakeholder participation in decisions and policies affecting biodiversity.

Additional needs include:

- Prioritizing where to invest in biodiversity conservation should consider climate change effects (e.g. areas under immediate threat or large unprotected areas in Central Amazon).

- Developing low-cost monitoring methods to better understand and verify land use – ecosystem service links, especially for dispersed service providers.

- Make equity considerations more transparent in design of schemes, providing for flexible land uses to absorb risks subject to external shocks while ensuring ecosystem service provision.

Recommendations for 2010

Recommendation 27. Obtain resources through user fees on resources use on environmental degradation on a scale adequate to cope with needs for biodiversity conservation, and by mainstreaming biodiversity in macroeconomic development policies.

Recommendation 28. Upscale ecosystem service payments to a global level, on a scale adequate to address the severity of the problem, irrespective of uncertainties;

Recommendation 29. Create Institutions with capacity to negotiate and implement payments for ecosystem services at different scales, with legal and financial resources;

Recommendation 30. Include forest conservation as part of global strategies to combat global warming, integrating climate and biodiversity objectives.