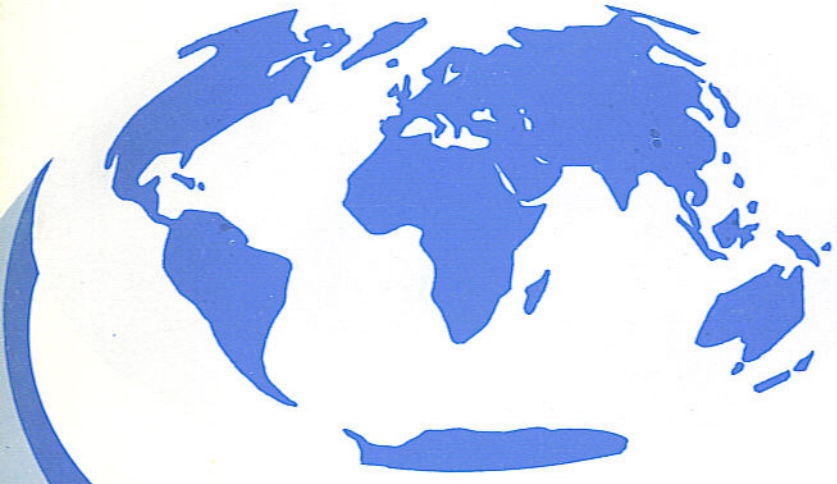
Biology International

The News Magazine of the International Union of Biological Sciences (IUBS)



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EDITORIAL

The Message from Rio

A year ago, an entire issue of *Biology International* was devoted to the 1992 United Nations Conference on the Environment and Development (UNCED), in Rio de Janeiro. Papers were included on biodiversity, forests, oceans, and environment and development education. In an introductory paper "From Stockholm to Rio...", Professor di Castri questioned the chances of success or failure of the Conference. In his opinion, this will depend on whether it will be a start, and not an end of a long-term process. A major factor will be its ability to bring in new actors -- non-profit associations, industrial communities and trade unions -- in addition to scientists and decision-makers.

Now, that the Conference has ended, the answer is yes, the Earth Summit was an outstanding success. Perhaps not nearly as complete as some might have wished, but far more than many had feared.

Rio de Janeiro was the site of the most important international encounter in history. The greatest concentration of heads of states and governments, 10 000 official delegates from 172 countries, and over 15 000 non-governmental organisation representatives, together with 9 000 accredited media professionals spreading the information around the world, made ECO '92 the largest open university ever organized.

An important feature of ECO '92 was to include three different types of meetings run in parallel: the governmental Summit -- the UNCED proper --, a large "Scientific Forum" cosponsored by UNESCO and the Government of Brazil, and a much larger "Global Forum", called the anti-Summit, since it brought together most of the world's grass-roots and other non-governmental organizations, and all kinds of groups and institutions interested in uniting both the issues of environment and development.

To scientists, possibly the most significant aspect of ECO '92 is that such an important political meeting was convened essentially on the basis of scientific findings and perceptions: biodiversity and biotechnologies, global warming, ozone whole, and deforestation and desertification. Moreover, the agreements recorded in the final documents- the "Rio Declaration", "Agenda 21", and the two framework Conventions constitute a concrete step forward. These accords are not enough, however, and must now be given content, necessitating more inputs from the international scientific community.

To biologists, the most relevant of the UNCED documents is undoubtedly the "Convention on Biological Diversity" (*Cf.* page 22 of this Issue). At the closing day of the Conference, this Convention was signed by 153 States, and will enter into force after ratification by 30 States.

The agreement on biodiversity contains provisions intended to ensure effective national action to curb the destruction of living species, habitats and ecosystems. But it also draws attention to the general lack of information and knowledge regarding biodiversity and to the urgent need to develop scientific, technical and institutional capacities to provide the basic understanding upon which to plan and implement appropriate measures.

From that end, *Diversitas*, the IUBS-SCOPE-UNESCO programme on Biodiversity, acquires an additional sense of urgency. Over 10 000 information leaflets on *Diversitas* were distributed at the Global Forum UNESCO Exhibit, and more than 500 participants attended the biodiversity session of the Scientific Conference. The conceptual framework provided by the programme, its basic themes, i.e., understanding the ecosystem function of biodiversity, the mechanisms of species extinctions, and the using a network approach for inventorying and monitoring biodiversity (see page 3), were widely seen as a prerequisite for an efficient and effective implementation of the Convention.

The second important document of the Summit is the "Framework Convention on Climate Change". Also signed by 153 States, the Convention aims at protecting the atmosphere from a build-up of anthropogenic gases that trap heat from the sun, causing an enhanced "greenhouse effect". This document sets out, as an objective, the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system. "Such a level", it states, "should be reached within a time-frame sufficient to allow ecosystems to adapt to climate change".

Furthermore, the Summit approved a binding "Statement of Forest Principles" recognizing the vital role of all types of forests in maintaining the ecological processes and balance at the local, national, regional and global levels, and a call for a Framework Convention on Desertification.

Covering all areas where environment and the economy intersect, "Agenda 21" is a comprehensive programme of action aimed at reshaping human activities in order to minimize environmental damage and ensure sustainability in the development process. Action-oriented proposals are divided into 40 chapters and more than 100 programme areas which are described in terms of the basis for action; objectives; activities and means of implementation, including financing and cost evaluation; as well as scientific and technological means.

The Summit succeeded in beginning the process of fully accounting for the integration of the environment and the economy. It also succeeded in bringing the population issue into the debate. Without population stabilization, all the efforts toward sustainable resource use and environmental protection would be in vain.

Scientists have the duty to contribute to the very ambitious endeavour that started at Rio, the first attempt by the world's nations to come to terms with how to manage these complex and ambiguous interdependencies: that between environment and economy, and that between the North and the South.

Talal Younés
Executive Director, IUBS

The Network Approach for Understanding Global Biodiversity

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Biodiversity: the lesson from Rio

With the concluding of the United Nations Conference on Environment and Development in June in Rio de Janeiro, never has there been more publicity given in the media to the topic of biodiversity. While much was achieved at this summit, the overall outcome showed that there is not yet political unanimity concerning the Convention on Biodiversity. Much of the difficulty stems from the important fact that science was largely absent from the debate. One major handicap in the discussions concerning the convention on biodiversity was reflected in the statement qualifying this convention as the 'Convention on the Unknown'.

The scientific information that was given in the general media tended either to be incorrect (e.g. there are 1.4 million species on Earth -- without saying that these represent the fraction of a total unknown biodiversity -- estimates vary from 4 million, to 100 million species) or was presented as hard fact, without taking into account the uncertainties, margins of error or the underlying assumptions.

But there was also a very positive side to this conference. In the first place, countries and most especially their leaders, fully realize the global character and the enormous stakes at hand of the loss of biodiversity. They fully realized that conservation of biodiversity is a type of insurance policy in the frenzy to defuse the environment-population-development time bomb. It is certain that the products of UNCED -- the chapter of Agenda 21 on biodiversity and the Convention on Biodiversity -- point directly to the need for more research and more inventories and monitoring. And that this point was stressed by delegations from both developing and industrialised countries.

In sum, there are several points raised by UNCED regarding biodiversity which need urgent attention by the scientific community:

1. the need to consider biodiversity as a building block for development;
2. the need to obtain better knowledge of species numbers, their distributions and rates of reduction and extinction;
3. the need to bring the best and most up to date information on biodiversity to the attention of policy makers;
4. the need to greatly step up education and awareness efforts on biodiversity.

This implies that studies on biodiversity need to be not only increased, but more especially re-considered in the global time and space scales in order to answer the needs of land managers, politicians, teachers, non-governmental action groups and the private sector, etc. Information needs to be collated and processed so that it can be used most efficiently and effectively by these different user groups.

Diversitas: the challenge

In order to meet the challenges outlined above, studies on biodiversity need to be more consolidated, coherent, and follow a given direction. If action is not taken along these lines, scientific work on biodiversity will continue to be dispersed and weak. The last two years have seen the publication of a vast literature on biodiversity, with many recommendations for action. These efforts are very laudable but very often lack coherence and direction. The WRI/UNEP/IUCN strategy on biodiversity, for example, gives an excellent and imaginative list of objectives and activities -- but these lack a unifying conceptual framework. The subject of biodiversity is too big and important to be left to a piecemeal, "blind-leading-the-blind" approach.

In this connection, the physical scientists have long managed to "get their act together" to address some of the world's major environmental questions and have launched the main environmental projects of today (c.f. the IGBP for global change, or the GOOS for understanding the ocean). It is time that the same be done for the biological sciences, and most especially for work on biodiversity. It is necessary to bring together ongoing and past studies on biodiversity and review and revise them as appropriate in a global context, thus stepping up the time and space scales.

In consequence, the IUBS-SCOPE-UNESCO programme *Diversitas* has a great responsibility in meeting the challenges to pave the "road after Rio". This programme aims to fill the knowledge gaps concerning the basic issues of:

1) the role of biodiversity in ecosystem function and sustainability;

2) the origins, maintenance and the loss of biodiversity; and

3) the distribution of biodiversity over both space and time scales.

Diversitas by its very definition must cover the diversity of all living beings on the planet. In consequence, it will address everything from whales to microbes, and thereby cover two aspects that have been somewhat neglected up until present: *marine biodiversity* and *microorganisms diversity*. Although *Diversitas* involves geneticists, physiologists, population biologists and ecologists, the contribution of taxonomists is crucial. The programme must address the question of removing the "taxonomic impediment" i.e. the acute shortage of trained taxonomists, the lack of specialists for many important groups of organisms, and the existence of a small number of reference collections, which are, in most cases, far from the place of origin of organisms being studied.

Moreover, *Diversitas* should try to demonstrate the viability of new types of partnerships advocated by UNCED between intergovernmental and non-governmental organisations in taking up this challenge. It should be able to take up the opportunities of new funding sources for biodiversity.

The network approach

As there are insufficient human and financial resources to study everything, a network approach is advocated to provide a conceptual and operational framework and a direction for studying biodiversity. A pilot core network is proposed made up of a minimum of selected sites representative of the Earth's biomes.

An open network

This network is open and can be expanded as opportunities arise. The matrix framework by biome means that other studies in other sites, both past and ongoing, can be "added" by placing them in reference to the ones that are already there, giving a new vantage point from which to view old data and assess them in the relative context of global biodiversity.

Compare the comparable

The rationale for this global network for inventorying and monitoring biodiversity is that we need to compare comparable sites (within the same biome, and between biomes) in terms of species' composition and function and their evolution over time, to obtain a more accurate and complete description of the spatial and temporal aspects of biodiversity.

Such a framework can be likened to a Mendeleev's table of the elements where the blank spaces can be filled in as work continues and our understanding of the relative importance and inter-relations of the pieces becomes more clear.

Zooming along and across scales

The idea of switching scales to better perceive processes, patterns and constraints is receiving increasing interest in ecology (di Castri and Hadley, 1988). There are several reasons for this, including the new awareness of the global coverage of biodiversity and the global impact of human activities upon it, the appreciation of the hierarchical view of life, going from the DNA molecule up to the landscape levels, as well as the seeming acceleration of history, such that rates of extinction are estimated to be 1000 time faster than the norm over evolutionary time. This perception of globalization is furthermore backed by the technologies that we have now on hand such as satellite imageries, computer link-ups, facsimile and electronic mail, etc. These combined features have made it less and less meaningful for scientists to work on their own, using their own personal methodologies on small sample sites. The younger ecologists of today are far more willing to work in teams on questions of global interest, using standard methods and software (Tinker, *per. com.* 1992).

Space scale

Moving up in the spatial scale is not without pitfalls and must be undertaken with some common sense. Studies on water pollution, for example, frequently transform measures made for several square metres into kg of matter per hectare without taking into account the buffering effect of large water bodies. Thus it has been shown that the global nutrient balance for an entire catchment area is positive, in spite of relatively large losses of nitrogen at the local site level due to the capacity of the valley floor to retain this nitrogen run-off (Meentemeyer, 1989). The hierarchical nature of biodiversity, going from the molecular up to the landscape and biosphere levels offers the same hurdles for

extrapolation.

This points to the importance of the approach of extensive and intensive inventories on biodiversity as described by di Castri, Robertson and Younès (1992). In this approach, a holistic view of biodiversity at the global level is proposed by using a suite of comparable sites (in the same biome) and similar sampling methodologies. The intensive sites form the controls against which the extensive sites can be calibrated. And the extensive sites are the replicates, covering different spatial areas.

Time scale

Moving up in the time scale is also essential. Here, as is true with most biological sciences, there is a need to reinstate the role of history and the role of change with time in a study of biodiversity. It is the long term studies which give the most meaningful results as they single out the gradual trends over time from the noisy fluctuations occurring over short time periods. Comparisons have been made between the assessed rates of extinctions over the geological eras with those estimated for present times, which gives a perspective of the magnitude of human impact on biodiversity (May, 1992). But we need to know more on more recently documented changes and link land use history with observations on selected species or groups. Hence the recourse to sites having long data sets to extrapolate backwards in time and to give more perspective to current observations.

Monitoring here refers to making repeated observations over time of a selected organism, or population, or functional group. Franklin (1989) notes that "monitoring should be rescued from its association, in some minds, with mindless data collection, and restored, where appropriate to our vocabulary. Monitoring is part of research." Indeed, the whole idea of monitoring here is the selection of the target organism with the underlying hypothesis that there will or there will not be any changes in, for example, population numbers or distribution according to time. Of course, it may take many years of patient and unrewarding observations to collect enough data to start to see any trend. However, correlations can be made with other parameters, such as climate, frequency of disturbances like fire or storms, etc., and comparisons made to discern any patterns or tendencies. It is then that certain hypotheses can be formulated and subsequently tested out.

'Global Biodiversity Network'

Within the framework of *Diversitas*, a key component consists of the establishment of a pilot 'Global Biodiversity Network', based upon biosphere reserves and other similar sites.

This network represents a basic tool for the conservation of genetic material and ecosystems as well as for the promotion of development in association with the environment. Also, it should provide the logistics necessary for the implementation of the programme research, training, education and demonstration activities (Fig. 1).

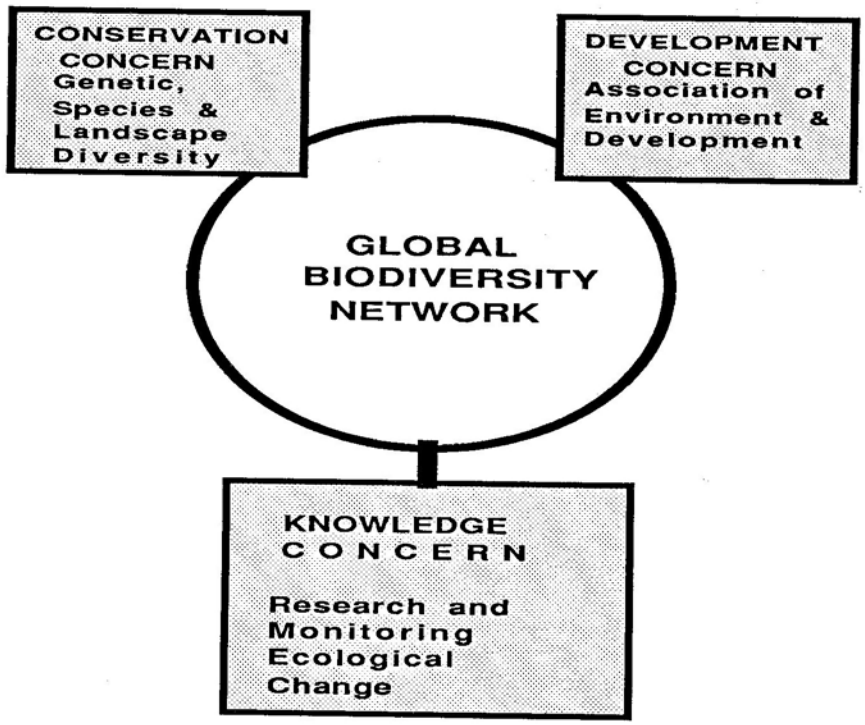

Figure 1: The Global Biodiversity Network showing the three major concerns related to conservation, development and knowledge.

Objectives

The principal objectives of the pilot Global Biodiversity Network are that the network:

-allows a coordinated programme which avoids duplication and even regression of work (going over the same ground again);

-promotes work into previously ignored areas, for example through the intensive inventories which will cover groups of species which may have not yet been studied in certain biomes;

-creates a synergism amongst the institutions and research teams working at the separate sites, giving an "added value" to the work undertaken at the local and national level;

-gives renewed interest, momentum and direction to systematics and taxonomy;

-provides new training and employment opportunities for young scientists within their countries;

-fosters cooperative relations amongst countries and research teams, and particularly the sharing of knowledge of experts (remembering, for example, that there are many specialists in tropical biology coming from the temperate countries);

-provides an authoritative information base for preparing environment and development educational material on biodiversity.

Functioning of the network

As with all research networks, the establishment and running of such a pilot network require a number of elements and conditions as follows:

-a good understanding and longer term commitment to the objectives and purpose of the programme on behalf of the participating sites and institutions;

-acceptance to using similar methodologies and sampling packages, to share data and pool results;

-an agreed methodology for data handling;

-strong leadership at the national and local site level;

-scientific guidance and evaluation by a coordinating committee at the international level;

-regular meetings of the different groups to exchange results and refine methods;

-assuring a minimal level of financial support over the first 5 years (for example by channelling existing financial and human resources and procuring additional funds for annual coordination meetings, and for specific tasks such as preparing sampling packs for extensive studies in the selected biomes), with the maximum level of funding going into the sites themselves;

-ensuring information exchange through newsletters and journals, etc.;

-ensuring the publication of results of the pilot network in the scientific literature, in popular material for the general public and in documents aimed at policy makers.

Conclusion

Biodiversity represents the ultimate result of life's evolutionary processes and mechanisms over very large time and space scales. In addressing the very complex and multifaceted issues of biodiversity conservation and management, we urgently need to fill the many gaps that still exist in our knowledge of biodiversity function, extinction, and distribution.

In this endeavour, more research, training, education and information are needed. Sites representative of both marine and terrestrial realms, and from different countries, are required. Also, the collaboration of a great variety of scientific skills and of a large number of actors in an interdisciplinary manner. We believe that a Global Biodiversity Network represents the ideal approach to bring about a new partnership and provide a basic tool to integrate in a harmonious and synergistic manner the three major concerns related to biodiversity, i.e., conservation, development, and research and monitoring.

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Geographic Information Systems (GIS) Applications in Biological Conservation

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Introduction

Data, information, knowledge, and wisdom are powerful tools in the transformation of the natural and man-made worlds. Current efforts to integrate man's influence on the natural ecosystems that support human culture and natural biodiversity in a sustainable manner are struggling with how to gather and process information more efficiently and effectively. The rapidity with which human populations are growing and changing natural ecosystems is a serious threat to the success of information management efforts as a contribution to sustainable human settlements and cultures.

Social and political processes often overpower objective scientific information analysis. Often "scientific" analysis fails to grasp the wisdom of peoples who live in greater intimate contact with the natural world. The empowerment of organizations, communities, and local governments to manage their own information and knowledge in a decentralized fashion is key in the success of sustainable natural resource management. Thus the ability to gather, integrate, analyze, maintain, and socialize information is a badly needed capacity in most regions of the world. The successful interface of modern computer technology with local social action and resource management is one of the challenges that conservationists face in comprehensive ecosystem conservation programmes.

In this paper we examine some of the history, needs for, capabilities, limitations, and applications of Geographic Information Systems in the tropical regions of the world for biological conservation and conservation based development.

Regional Analysis and Information Integration

Tropical biologists and ecologists are making great strides in the development of knowledge and understanding of tropical forests and other ecosystems that harbour high and complex biodiversity and ecosystem functions. Nevertheless, the use of this knowledge at the governmental and social level, both local and national, is sparse. Clearly, there is a growing recognition at all levels (global, national, and local) of these ecological precepts, but actual integration of ecological and socio-economic information into the decision process and the traditional approach to development is difficult, politically overruled, or often just ignored.

Existing data sets on biological diversity have not been used to their full potential for regional planning. This is due to a lack of awareness of their importance, lack of communication between scientific/technical and decision levels, and of access to the data sets and the tools to integrate them efficiently with other types of information. Ecosystem and conservation scientists need to provide planners an understandable view of the

interconnections between ecosystem components and how they support economic development. Conservation information should be presented in a manner which enriches the knowledge of land managers, providing perspectives that demonstrate relationships between resources. Decision strategies that incorporate a fuller range of existing knowledge must be utilized that also allow the integration of new information when it becomes available in the future.

The importance of being able to analyze and communicate the geographical and ecological relationships between different resources has increased as the awareness of the complexity of these systems and their management has developed. In addition to portraying the importance of biological conservation to basic land resource management analyses must show where solutions need to be applied on the ground (geographic priorities) and where different but interconnected problems occur at the same time on the landscape, thus allowing an integrated and more efficient management of these problems.

There is a growing need not only to improve our analysis techniques of complex problems, but also to be able to communicate the results in an effective manner to a diverse public including governmental decision makers, technical personnel, and local communities. Skills in information processing, presentation, and promotion are required to assemble heretofore un-integrated information to provide a more whole picture. Databases are obviously needed, but if not synthesized and promoted to policy makers they end up no different than unused libraries.

The timing of social and economic pressures for land development will not allow for the development of a complete understanding of tropical biota. In the face of accelerating processes of land resource change and degradation we need to use tools that accelerate our ability to process information about those changes. A geographic information system (GIS) is a logical tool to use in this endeavour. Many aspects of GIS available now on microcomputer are appropriate for institutions at the local or regional level in less developed regions of the world.

Maps are an effective tool for presenting large amounts of information quickly and effectively. A GIS combines information of different types and sources. Maps and tables, if based in a GIS, can provide a useful framework for the short and long-term development of the information necessary for conservation planning and management within the limitations of existing data. GIS also serves as an effective tool for spatial analysis and research. GIS provides a dynamic information product which can be periodically updated to reflect constantly changing conditions. It employs techniques that are applicable at any geographic level; national, regional or local.

Traditional maps take too long to produce, require specialized skills and their production is expensive. On the other hand, a traditional GIS implementation tends, in the framework of most developing nations, to centralize information management and the analysis process. This is a result of the high investment level they usually require, the demand for scarce trained personnel, the needs for an "adequate" operational environment for the equipment (including access to maintenance).

Thus, many implementations of GIS in less developed countries have not been successful due to the creation of highly centralized information bureaucracies with little flexibility, high long-term operational costs, and the inability to respond to real user needs.

In recent years, the development of micro-computers and their widespread availability has provided a new alternative. Their increasing power allows users to run complex systems,

their lower cost and ease of distribution simplifies access and maintenance of the technology, and reverses the tendency towards centralization. New software has been and continues to be developed that simplifies the application of GIS technologies in small non-governmental organizations in the environmental fields. This is a shift in the way that information is collected, managed, and used for the conservation and development of natural resources.

The growing consequences at the field level for biological conservation and sustainable development of this shift in information management capability are potentially far reaching. Environmental information on potential projects, impacts, and conflicts of development programmes will be managed on a regional and community basis. Local organizations of many types will develop the informational capacity to guide, contest, or provide alternatives for the development of land resources. Information in this manner becomes a socially dispersed good rather than a highly controlled power element. It is in this information environment that biological conservation will be integrated as part of the development process.

What is GIS and What Can It Do?

GIS can be defined as "a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial from the real-world for a particular set of purposes" (Burrough, 1986). This broad definition hides the fact that GIS was the product of the evolution and the confluence of some very different disciplines and methods including cartography, surveying and photogrammetry, remote sensing, spatial analysis, and computer aided design and computer graphics.

Early GIS development history was determined by demand for some specific products: the automatic production of high quality cartography in a cost effective way, and the development of satellite image analysis capabilities.

These two demands shaped the initial development of GIS systems, and still influence much of it. In this sense, GIS provides input to the planning process (through classified images, and precise cartography), but does not provide the framework for the planning process itself. Even until recent years it was difficult to mix the two type of products, and even nowadays it is difficult to find experts in both types of analysis.

Only recently has GIS development focused on the enhancement of the analytical capabilities of the system: improving their spatial analysis capacities, including access to relational databases, facilitating the integration of geographical information from diverse sources, facilitating reporting capacities, and developing analytical skills based on real-world planning and management problems.

The application of GIS in the conservation field has been enhanced by these improvements, and by the fact that some of the new systems are of lower cost, easier to maintain and require less training, facilitating their use under field conditions. In conservation, the real power of GIS is in its ability to assist in the construction of long-term data bases for iteratively accumulating knowledge on natural and social systems, allowing the development of predictive monitoring and trend analysis, and the evaluation of planning and management scenarios.

Nevertheless, at the market level we still find many different systems being offered, and

each of them have specialized niche-markets, making the process of choosing the appropriate system for the appropriate tasks more difficult. These systems normally integrate more than one capability, but often enhance one of them: they either show a bias toward automatic cartography with high quality mapping capacities, a geo-encyclopedia with geographic query, an image analysis capacity, or they focus on developing spatial analysis. Normally each of these capacities implies different alternatives for hardware as well as software, and have profound influence on the level of investment, the quantity and qualifications of the technical personnel, the minimum requirements for the operating environment, the need for sustained technical assistance and training, the dependence from outside services (maintenance, data acquisition, printing and graphics services, etc.) that affect the viability of the system in the context we normally face for conservation projects.

What type of system is the one critical to the conservation field? We think it is the family of GIS' that concentrate on spatial analysis using hardware that can normally run and be maintained in field conditions (standard PC-compatible equipment, avoiding expensive or hard-to-service peripherals), with low requirements for training. Above all, GIS in conservation must effectively complement ongoing projects in a decentralized fashion, without having to develop highly specialized staff for GIS support.

Specifically, GIS in conservation needs to be analytically powerful, multi-lingual, easy to learn and use (menu driven), have an easy interface with relational database software (such as Dbase III+), be able to import and export information to and from other types of GIS and database formats.

GIS Applications in Conservation

The following examples portray some recent experiences in the use of GIS in tropical conservation. By no means comprehensive, they have been selected to provide a sample of different applications that are relevant to the real problems that conservationists face in the field.

Land use conflicts in La Amistad Biosphere Reserve in Costa Rica.

The Coordinating Commission for La Amistad Biosphere Reserve (RBA) in Costa Rica has been successfully using GIS for analyzing the land use and land ownership relationships in the indigenous reserves that form part of the RBA. The situation of this reserve is frequent throughout Latin America: the full establishment and delimitation of the reserve was not completed early in the process and as a result there are contradictions in land use that are difficult to resolve, such as long term dwellers in areas supposed to be part of the core area of the reserve, incompatible land uses in part of the buffer areas, and so forth. In addition, the Indian reserves that are part of the RBA have non-Indian residents with different environmental demands, some of which may not be compatible with a sustainable management of the biosphere reserve.

GIS has played an important role in clarifying these problems, integrating the information, analyzing present land use patterns, analyzing management alternatives, and establishing a body of organized information for dealing with these issues both on a day-to-day basis and for longer-term policy studies.

Fragmentation analysis in the Mata Atlantica in Brazil.

Biodiversitas Foundation, established in Belo Horizonte, in the state of Minas Gerais, has been using GIS in the analysis of forest remnants of the Atlantic forests. Tropical forests in this critical ecosystem amount only to 2 to 5% of their original extent. This ecosystem has a high level of endemism, making it one of the highest conservation priorities worldwide. One key issue where GIS is useful is the analysis of forest remnants, their location, size, type, and structure in order to estimate their habitat quality, present state, and stability. It is also possible to assess the impact of different management options for enhancing habitat quality. These management options include, among others, the establishment of biological corridors to link patches, the restoration of degraded sites, and the identification of areas critical for management. The GIS is also useful for estimating the level of resources needed by those management options: land area affected, number of personnel needed, cost of lands, and so on.

Biodiversity analysis in Oaxaca-Guerrero, Mexico.

One of the problems usually encountered in biodiversity analysis is the successful integration of field data for the analysis of biodiversity distribution in complex areas. We have mastered the field survey methods, but the limiting factor has been how to integrate species distribution information meaningfully -- and easily -- with environmental factors and how to feedback this analysis in order to more effectively plan for the field surveys.

The UNIRBMEX unit of the Center of Ecology of the National Autonomous University of Mexico has been using GIS to undertake this task, studying biodiversity distribution in a complex area of Mexico: the dry tropical forests of the states of Oaxaca and Guerrero in the southwest of Mexico. They have used GIS to successfully integrate and analyze thousands of field data points on hundreds of species; correlating this data with environmental factors, estimating areas of potential distribution of species (which can be field checked), and then analyzing the overlap of these species distribution patterns on the landscape, thus identifying areas critical for conservation management.

Analysis of development projects in the Lacandona Forest in Mexico.

This project was developed by the Instituto de Historia Natural (Chiapas, Mexico) and Conservation International, in coordination with the World Bank and the Mexican government. Its objectives were to highlight how a GIS could be helpful for regional analysis and planning in the context of the projects the World Bank and Government of Mexico were developing in the Lacandona Forest area. This area of traditional occupation by the Lacandon Indians and includes the Montes Azules Biosphere Reserve. The reserve is undergoing profound transformations as a result of colonization that has occurred in the region during the past decades.

The GIS database developed for the project covered a large area of influence of the biosphere reserve and included data on the natural environment, demography, project sites and level of investment. This database allowed the analysis of the colonization process, its spatial linkage to proposed development projects, the analysis of trends in territorial occupation, and alternatives for sustainable land use in the buffer zone of the reserve. The GIS also permitted the identification of potential areas for the extension of the reserve (as was recently approved by the Government of Mexico).

Defining Conservation Priorities in the Amazon Basin and in Papua, New Guinea.

One area of particular importance for GIS use is in the analysis of conservation policy options at regional levels. This analytical realm is critical for influencing government policy, but needs to integrate diverse information from different fields (natural sciences, social issues, economy, government, etc.), information that is often incomplete, qualitative, and lacking detail. In this field the potential of GIS as a way of synthesizing the expertise of the parties involved in the policy exercise becomes crucial.

Two successful experiences of policy workshops have been developed, one for the Amazon Basin (Workshop '90, Manaus, January 1990) and the Papua, New Guinea Conservation Priorities Workshop (Madang, PNG, April 1992). In both cases the approach was similar: a workshop that convened the best field experts who used maps to determine priority areas for conservation based on their field experience and a GIS-developed database to integrate their knowledge with different disciplines. The result is a synthesis of the best available knowledge on these critical areas, in a format that is suitable for use at the policy level, and for communication and discussion at the social level. An important product of the effort is a regional database that can be used for analyzing alternative policies, their impacts, and for follow-up on existing natural resources management practices, establishing a first information framework for sustainable environmental management.

All of these applications of GIS in the conservation field were done using CISIG, a GIS software developed by Conservation International in response to our perception of the limiting factors facing conservation activities in Latin America. CISIG follows most of the guidelines that we have presented in this paper. It is a vector/raster system, strong in analytical capabilities, that handles also DBase III+ compatible relational databases. It runs on PC-compatible systems (286 minimum) with minimal requirements for peripheral equipment (digitizer and printer). It is now available in a bilingual version (Spanish and English) and will soon support a total of four languages (Portuguese and French). It is now running in approximately 50 institutions throughout Latin America, with some installations in Africa and Asia. These institutions include research and academic, government agencies, NGO's, and community-based projects.

Conclusions

GIS can be a powerful tool in the conservation field, both for biological and ecological research, and for planning and management of natural resources and the environment. Our experience has shown that the demand for it is high in all types of institutions and organizations in the lesser developed countries. Software and hardware are increasingly available in appropriate forms for building and integrating data and implementing analysis projects.

Nevertheless, the critical ingredient in successfully solving conservation problems resides with the knowledge and understanding of the problem itself, and not necessarily on how powerful the tool we are using might be. What is important in the conservation field is to develop the capabilities of local organizations by addressing regional analysis and planning, the essence of the issues, rather than focussing on the technology. The use of GIS technology thus fits into the process as a tool, not as an end.

To develop this organizational capacity requires that training in the context of real projects must be undertaken that address concrete problems and thus provide valid analytical training. Exchanging the experiences of organizations on a regional and continental basis is extremely important in strengthening the appropriate use of GIS. The development of formal networks (both organizational and electronic) is seen a key to overcoming the traditional lack of technical support, idea exchange, and isolation in problem solving that small organizations typically face.

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Interdisciplinarity and Environment and the Flaming Moth Principle

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Why Interdisciplinarity in Tackling Environmental Problems?

There are several reasons why environmental problems require an interdisciplinary approach. Most basically, interactions between natural and social systems and processes lie at the heart of such problems as conflicting alternatives for development (agriculture, industry and tourism) in a given mountain or coastal area; exchange of products between tropical lowlands and highlands; competition or complementarity between extensive grazing and sedentary agriculture in semi-arid zones; impact of urbanization on surrounding or distant environments.

Environmental issues like these can be thought of quintessentially as "wicked" problems- ill-defined and difficult to bind, with many components (geophysical, psycho-social, etc.); the contrast is with "tame" problems, those than can be effectively bound and about which there is adequate unambiguous information (Brightman, 1978; Miller, 1975). The natural and social processes subtending such issues are coupled and interrelated, and the major research questions transcend traditional disciplinary bounds. The contemporary wisdom is that the very nature of these problems means that they cannot be resolved by adopting a narrow, single-purpose approach. What is required is a holistic, interdisciplinary research effort, with a repertoire of cognitive studies being brought to bear on the problem at hand (Miller, 1985).

Another stimulus for interdisciplinarity - true of science as a whole - is that of learning from other disciplines. Researchers trained in particular disciplines have long recognized that much can be learned from the approaches, paradigms, concepts and techniques of other disciplines and sub-disciplines. To an extent that one commentator has suggested sharpening the criterion of scientific merit "by proposing that, other things being equal, that field has the most merit which contributes most heavily to, and illuminates more brightly, its neighbouring scientific disciplines" (Weinberg, 1963; cited from Mackay, 1991, page 257).

In a similar vein, in much research on environmental systems, the outputs of one discipline are the input or boundary condition of another. Obvious examples are the use made by pedologists and hydrologists of the data of the meteorologist, or by livestock specialists of information on herbage production provided by the botanist, or by resource economists of crop yield data recorded by agronomists.

Steps in Interdisciplinary Research

A number of principal steps or ingredients have been proposed for shaping interdisciplinary research on environmental issues (di Castri, 1985; di Castri & Hadley, 1986) which can help contribute to such research attaining the hopes and objectives invested in it.

-Identify the problem, recognizing that either science or policy can be the point of entry for interdisciplinary research projects on environmental issues;

-Distil the precise scientific target from the social demands, which may entail having an identifiable client group to which a given research project can be directed;

-Select the disciplines and researchers, eliminating as many parameters as possible from the research design and concentrating the research project on the most critical of the interactions of the problem at hand;

-Chose the area and scale of study, as a function of the problem being addressed and taking due account of the different dimensions of space, time, and perception;

-Encourage working methods which allow for flexibility, feedback and the ability to react and to adapt quickly to the moving targets of change, caused by either internal or external factors;

-Develop a continuum of actions, wherever possible linking basic and applied research, demonstration and training, popularization and education;

-Establish from the outset the rules of the game (in other words, the principles for assessment and evaluation), which should explicitly recognize the "right to error", a necessary prerequisite for innovation.

Obstacles to Interdisciplinary Research

Attempts to put into practice interdisciplinary approaches to environmental issues have shown their worth, if given a chance. But the constraints encountered in putting these approaches into practice have been many and deep-seated (Whyte, 1982; 1984; di Castri *et al*, 1986; Whiston, 1986; di Castri & Hadley, 1986). Some of these constraints are of a scientific character or internal to the scientific community; they concern, for example, the quality and quantity of existing information and local manpower, the behavioural and psychological characteristics of individual scientists, career considerations, and questions of method and approach. Other constraints are of a more administrative, institutional, political, and financial nature.

Of all these obstacles and constraints to interdisciplinary effort (institutional, financial, behavioural, methodological), the common precursor and deep-seated root is the prevailing system of education, based as it is on disciplines. With a few notable exceptions, educational institutions, throughout the world, at all levels, are organized along nineteenth century disciplinary lines, and perpetuate traditional disciplinary views of the structure of knowledge. This disciplinary legacy has brought with it structural barriers to studies that cut across disciplines. There are communication problems between all disciplines but the division between the natural and the social sciences has

been greater, and therefore more difficult to bridge, than the boundary between two natural sciences such as botany and geology, or between social sciences like anthropology and sociology. Educational institutions tend to divide academic disciplines into "arts" and "science" and separate both of them from more vocationally oriented training in medicine, engineering, law, business or management. Each of these fields has its own sense of corporatism, whose members favour - consciously or not - the approaches, paradigms and information networks of their own particular discipline and profession.

Career paths and rewards also encourage scientists to remain within the disciplines, rather than to move freely between them or to work on the boundaries. University careers in many countries continue to be determined by rules and customs which often work against problem-oriented teamwork. For example, single author publications may be held in considerably higher esteem by universities than multi-authored works; moreover, the disciplinary orientation of reviewers may militate against interdisciplinary research projects and papers.

The disciplinary structure of academia is reflected in the institutions that deal with environmental and land use issues - whether these be national or international, governmental, non-governmental, or private. These institutions and their constituent departments tend to be staffed with people from similar disciplinary backgrounds or from the same profession, and communication problems between disciplines become replicated as sectoral divisions. Institutions created on a compartmental basis have an inherent inertia which resists attempts to set up integrated groups made up of different disciplines, and it is in this institutional and structural inertia that are found some of the most intractable constraints to interdisciplinary work.

In turn, disciplinary and institutional compartments gave rise to other problems connected with interdisciplinarity in environmental issues, including the amoebic funding of research and the methodological and epistemological challenges associated with different paradigms, approaches, technical terms, capacities for quantifying results, etc. These differences make communication and working together difficult, with questions of scale, of basic scientific method and of theory of particular importance in setting up interdisciplinary research efforts involving natural and social sciences.

Responding to Paradox

There is nothing very new in calls for interdisciplinary approaches to environmental issues. At the international level, the United Nations Environment Programme (UNEP), the Scientific Committee on Problems of the Environment (SCOPE), and the Man and the Biosphere (MAB) Programme of UNESCO are three initiatives that were established in the early 1970s, whose very philosophy predicates an interdisciplinary approach to environmental issues. More recently, in the mid-1980s, the International Geosphere/Biosphere Programme (IGBP) and the Human Dimensions of Global Change Programme (HDGCP) have been set up to address global change issues, with their respective roots in the natural and social sciences but sharing an advocacy for interdisciplinarity.

Individually and collectively, these initiatives can be considered to have some real accomplishments to their credit, in their respective fields of competence and activity. And yet the state of the environment in 1992 (twenty years after the UN Stockholm

Conference on the Human Environment) is surely worse than in 1972. As with most other social phenomena and processes, it is not possible to establish a control. No one is really able to say what differences there would be in the environment of 1992 if initiatives and programmes such as these had not existed.

This said, three paradoxes lie at the heart of the present situation (di Castri, 1990). A first paradox is that of the widely different speeds of change - the high rate of deterioration in our ecological systems contrasting with the low speed and inadequate focus of solutions proposed for addressing enormously complex problems. A second paradox concerns more particularly the scientific community. Whereas in several countries scientific policies aimed at obtaining precise and rapid responses to the crucial problems of the environment are in fact being put into place, research organizations and universities can only meet this challenge in an incomplete and inadequate way. A third paradox springs from the fact that environmental problems are interdependent both in time and space, while research activities and development actions are characterized by being carried out in isolation and with a certain presumptuousness.

It has to be hoped that processes of questioning and institutional reform, associated with such activities as the UN Conference on Environment and Development, might narrow the shortfall between needs and actions, and lead to real change in behaviour by each individual, each institution, and each state. Otherwise, we are all the hostage of the necessary changes being provoked by a major environmental catastrophe from which no one would be secure. We would then be very much a victim of what Boyden (1992, page 64) has called the "flaming moth principle" - the notion that a characteristic that has a selective advantage in one environment is of distinct disadvantage in changed situations.

It is a common observation that at night-time moths often fly directly into exposed flames, thereby incinerating themselves. This behaviour, which is apparently an expression of an innate behavioural characteristic of these insects, is clearly not, under new circumstances, of biological advantage to the moth. Nevertheless, the instinct which underlies this behaviour is the product of natural selection, and consequently can be assumed to be of selective advantage in the environment in which moths normally live and in which naked flames are a rare occurrence. In the changed or "evodeviant" situation, however, the instinct represents a distinct survival disadvantage to individual moths, and to moth populations.

How apt is the analogy with disciplinarity? Narrowly focussed reductionist approaches are fine for addressing some problems in certain circumstances, but are completely inadequate for qualitatively different situations, such as those presented by environment-development issues at the turn of the millennium.

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Convention on Biological Diversity

Preamble

The Contracting Parties,

Conscious of the intrinsic value of biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components,

Conscious also of the importance of biological diversity for evolution and for maintaining life sustaining systems of the biosphere,

Affirming that the conservation of biological diversity is a common concern of humankind,

Reaffirming that States have sovereign rights over their own biological resources,

Reaffirming also that States are responsible for conserving their biological diversity and for using their biological resources in a sustainable manner,

Concerned that biological diversity is being significantly reduced by certain human activities,

Aware of the general lack of information and knowledge regarding biological diversity and of the urgent need to develop scientific, technical and institutional capacities to provide the basic understanding upon which to plan and implement appropriate measures,

Noting that it is vital to anticipate, prevent and attack the causes of significant reduction or loss of biological diversity at source,

Noting also that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat,

Noting further that the fundamental requirement for the conservation of biological diversity is the *in-situ* conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings,

Noting further that *ex-situ* measures, preferably in the country of origin, also have an important role to play,

Recognizing the close and traditional dependence of many indigenous and local communities embodying traditional lifestyles on biological resources, and the desirability of sharing equitably benefits arising from the use of traditional knowledge, innovations and practices relevant to the conservation of biological diversity and the sustainable use of its components,

Recognizing also the vital role that women play in the conservation and sustainable use of biological diversity and affirming the need for the full participation of women at all levels of policy-making and implementation for biological diversity conservation,

Stressing the importance of, and the need to promote, international, regional and global cooperation among States and intergovernmental organizations and the non-governmental sector for the conservation of biological diversity and the sustainable use of its components,

Acknowledging that the provision of new and additional financial resources and appropriate access to relevant technologies can be expected to make a substantial difference in the world's ability to address the loss of

biological diversity,

Acknowledging further that special provision is required to meet the needs of developing countries, including the provision of new and additional financial resources and appropriate access to relevant technologies,

Noting in this regard the special conditions of the least developed countries and small island States,

Acknowledging that substantial investments are required to conserve biological diversity and that there is the expectation of a broad range of environmental, economic and social benefits from these investments,

Recognizing that economic and social development and poverty eradication are the first and overriding priorities of developing countries,

Aware that conservation and sustainable use of biological diversity is of critical importance for meeting the food, health and other needs of the growing world population, for which purpose access to and sharing of both genetic resources and technologies are essential,

Noting that, ultimately, the conservation and sustainable use of biological diversity will strengthen friendly relations among States and contribute to peace for humankind,

Desiring to enhance and complement existing international arrangements for the conservation of biological diversity and sustainable use of its components, and

Determined to conserve and sustainably use biological diversity for the benefit of present and future generations,

Have agreed as follows:

Article 1. Objectives

The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

Article 2. Use of Terms

For the purposes of this Convention:

"Biological diversity" means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.
"Biological resources" includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.

"Biotechnology" means any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

"Country of origin of genetic resources" means the country which possesses those genetic resources in *in-situ* conditions.

"Country providing genetic resources" means the country supplying genetic resources collected from

in-situ sources, including populations of both wild and domesticated species, or taken from *ex-situ* sources, which may or may not have originated in that country.

"Domesticated or cultivated species" means species in which the evolutionary process has been influenced by humans to meet their needs.

"Ecosystem" means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

"Ex-situ conservation" means the conservation of components of biological diversity outside their natural habitats.

"Genetic material" means any material of plant, animal, microbial or other origin containing functional units of heredity.

"Genetic Resources" means genetic material of actual or potential value.

"Habitat" means the place or type of site where an organism or population naturally occurs.

"In-situ conditions" means conditions where genetic resources exist within ecosystems and natural habitats, and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

"In-situ conservation" means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

"Protected area" means a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.

"Regional economic integration organization" means an organization constituted by sovereign States of a given region, to which its member States have transferred competence in respect of matters governed by this Convention and which has been duly authorized, in accordance with its internal procedures, to sign, ratify, accept, approve or accede to it.

"Sustainable use" means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

"Technology" includes biotechnology.

Article 3. Principle

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Article 4. Jurisdictional Scope

Subject to the rights of other States, and except as otherwise expressly provided in this Convention, the provisions of this Convention apply, in relation to each Contracting Party:

a) In the case of components of biological diversity, in areas within the limits of its

national jurisdiction; and

b) In the case of processes and activities, regardless of where their effects occur, carried out under its jurisdiction or control, within the area of its national jurisdiction or beyond the limits of national jurisdiction.

Article 5. Cooperation

Each Contracting Party shall, as far as possible and as appropriate, cooperate with other Contracting Parties, directly or, where appropriate, through competent international organizations, in respect of areas beyond national jurisdiction and on other matters of mutual interest, for the conservation and sustainable use of biological diversity.

Article 6. General Measures for Conservation and Sustainable Use

Each Contracting Party shall, in accordance with its particular conditions and capabilities:

a) Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, *inter alia*, the measures set out in this Convention relevant to the Contracting Party concerned: and

b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.

Article 7. Identification and Monitoring

Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of Articles 8 to 10:

a) Identify components of biological diversity important for its conservation and sustainable use having regard to the indicative list of categories set down in Annex I;

b) Monitor, through sampling and other techniques, the components of biological diversity identified pursuant to subparagraph (a) above, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use;

c) Identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques; and

d) Maintain and organize, by any mechanism data, derived from identification and monitoring activities pursuant to subparagraphs (a), (b), and (c) above.

Article 8. *In-Situ* Conservation

Each Contracting Party shall, as far as possible and as appropriate:

a) Establish a system of protected area or areas where special measures need to be taken to conserve biological diversity;

b) Develop, where necessary, guidelines for the selection, establishment and management of protected area or areas where special measures need to be taken to conserve biological diversity;

c) Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use;

d) Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings;

e) Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to further protection of these areas;

f) Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species, *inter alia*, through the development and implementation of plans or other management strategies;

g) Establish or maintain means to regulate, manage or control the risks associated with the use and release of living modified organisms resulting from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking also into account

the risks to human health;
h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species;
i) Endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the sustainable use of its components;
j) Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices;
k) Develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations;
l) Where a significant adverse effect on biological diversity has been determined pursuant to Article 7, regulate or manage the relevant processes and categories of activities; and
m) Cooperate in providing financial and other support for *in-situ* conservation outlined in subparagraphs (a) to (l) above, particularly to developing countries.

Article 9. *Ex-Situ* Conservation

Each Contracting Party shall, as far as possible and as appropriate, and predominantly for the purpose of complementing *in-situ* measures:
a) Adopt measures for the *ex-situ* conservation of components of biological diversity, preferably in the country of origin of such components;
b) Establish and maintain facilities for *ex-situ* conservation of and research on plants, animals and micro-organisms, preferable in the country of origin of genetic resources;
c) Adopt measures for the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions;
d) Regulate and manage collection of biological resources from natural habitats for *ex-situ* conservation purposes so as not to threaten ecosystems and *in-situ* populations of species, except where special temporary *ex-situ* measures are required under subparagraph (c) above; and
e) Cooperate in providing financial and other support for *ex-situ* conservation outlined in subparagraphs (a) to (d) above and in the establishment and maintenance of *ex-situ* conservation facilities in developing countries.

Article 10. Sustainable Use of Components of Biological Diversity

Each Contracting Party shall, as far as possible and as appropriate:
a) Integrate consideration of the conservation and sustainable use of biological resources into national decision-making;
b) Adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity;
c) Protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements;
d) Support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced; and
e) Encourage cooperation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources.

Article 11. Incentive Measures

Each Contracting Party shall, as far as possible and as appropriate, adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biological diversity.

Article 12. Research and Training

The Contracting Parties, taking into account the special needs of developing countries, shall:
a) Establish and maintain programmes for scientific and technical education and training in measures for the identification, conservation and sustainable use of biological diversity and its components and provide support for such education and training for the specific needs of developing countries;
b) Promote and encourage research which contributes to the conservation and sustainable use of biological diversity, particularly in developing countries, *inter alia*, in accordance with decisions of the Conference of the Parties taken in consequence of recommendations of the Subsidiary Body on Scientific, Technical and Technological Advice; and
c) In keeping with the provisions of Articles 16, 18 and 20, promote and cooperate in the use of scientific advances in biological diversity research in developing methods for conservation and sustainable use of biological resources.

Article 13. Public Education and Awareness

The Contracting Parties shall:
a) Promote and encourage understanding of the importance of, and the measures required for, the conservation of biological diversity, as well as its propagation through media, and the inclusion of these topics in educational programmes; and
b) Cooperate, as appropriate, with other States and international organizations in developing educational and public awareness programmes, with respect to conservation and sustainable use of biological diversity.

Article 14. Impact Assessment and Minimizing Adverse Impacts

1. Each Contracting Party shall, as far as possible and as appropriate, shall:
a) Introduce appropriate procedures requiring environmental, impact assessment of its proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimizing such effects and, where appropriate, allow for public participation in such procedures;
b) Introduce appropriate arrangements to ensure that the environmental consequences of its programmes and policies that are likely to have significant adverse impacts on biological diversity are duly taken into account;
c) Promote, on the basis of reciprocity, notification, exchange of information and consultation on activities under their jurisdiction or control which are likely to significantly affect adversely the biological diversity of other States or areas beyond the limits of national jurisdiction, by encouraging the conclusion of bilateral, regional or multilateral arrangements, as appropriate;
d) In the case of imminent or grave danger or damage, originating under its jurisdiction or control, to biological diversity within the area under jurisdiction of other States or areas beyond the limits of national jurisdiction, notify immediately the potentially affected States of such danger or damage, as well as initiate action to prevent or minimize such danger or damage; and
e) Promote national arrangements for emergency responses to activities or events, whether caused naturally or otherwise, which present a grave and imminent danger to biological diversity and encourage international cooperation to supplement such national efforts and, where appropriate and agreed by the States or regional economic integration organizations concerned, to establish joint contingency plans.

2. The Conference of the Parties shall examine, on the basis of studies to be carried out, the issue of liability and redress, including restoration and compensation, for damage to biological diversity, except where such liability is a purely internal matter.

Article 15. Access to Genetic Resources

1. Recognizing the sovereign rights of States over their natural resources, the authority to determine access to genetic resources rests with the national governments and is subject to national legislation.

2. Each Contracting Party shall endeavour to create conditions to facilitate access to genetic resources for environmentally sound uses by other Contracting Parties and not to impose restrictions that run counter to the objectives of this Convention.

3. For the purposes of this Convention, the genetic resources being provided by a Contracting party, as referred to in this Article and Articles 1[illegible] and 19, are only those that are provided by Contracting Parties that are countries of origin of such resources or by the Parties that have acquired the genetic resources in accordance with this Convention.

4. Access, where granted, shall be on mutually agreed terms and subject to the provisions of this Article.

5. Access to genetic resources shall be subject to prior informed consent of the Contracting Party providing such resources, unless otherwise determined by that Party.

6. Each Contracting Party shall endeavour to develop and carry out scientific research based on genetic resources provided by other Contracting Parties with the full participation of, and where possible in, such Contracting Parties.

7. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, and in accordance with Articles 16 and 19, and, where necessary, through the financial mechanism established by Articles 20 and 21 with the aim of sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilization of genetic resources with the Contracting Party providing such resources. Such sharing shall be upon mutually agreed terms.

Article 16. Access to and Transfer of Technology

1. Each Contracting Party, recognizing that technology includes biotechnology, and that both access to and transfer of technology among Contracting Parties are essential elements for the attainment of the objectives of this Convention, undertakes subject to the provisions of this Article to provide and/or facilitate access for and transfer to other Contracting Parties of technologies that are relevant to the conservation and sustainable use of biological diversity or make use of genetic resources and do not cause significant damage to the environment.

2. Access to and transfer of technology referred to in paragraph 1 above to developing countries shall be provided and/or facilitated under fair and most favourable terms, including on concessional and preferential terms where mutually agreed, and, where necessary, in accordance with the financial mechanism established by Articles 20 and 21. In the case of technology subject to patents and other intellectual property rights, such access and transfer shall be provided on terms which recognize and are consistent with the adequate and effective protection of intellectual property rights. The application of this paragraph shall be consistent with paragraphs 3, 4 and 5, below.

3. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, with the aim that Contracting Parties, in particular those that are developing countries, which provide genetic resources are provided access to and transfer of technology which makes use of those resources, on mutually agreed terms, including technology protected by patents and other intellectual property rights, where necessary, through the provisions of Articles 20 and 21, and in accordance with international law and consistent with paragraphs 4 and 5 below.

4. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, with the aim that the private sector facilitates access to, joint development and transfer of technology referred to in paragraph 1 above for the benefit of both governmental institutions and the private sector of developing countries and in this regard shall abide by the obligations included in paragraphs 1, 2 and 3 above.

5. The Contracting Parties, recognizing that patents and other intellectual property rights may have an

influence on the implementation of this Convention, shall cooperate in this regard subject to national legislation and international law in order to ensure that such rights are supportive of and do not run counter to its objectives.

Article 17. Exchange of Information

1. The Contracting Parties shall facilitate the exchange of information, from all publicly available sources, relevant to the conservation and sustainable use of biological diversity, taking into account the special needs of developing countries.

2. Such exchange of information shall include exchange of results of technical, scientific and socio-economic research, as well as information on training and surveying programmes, specialized knowledge, indigenous and traditional knowledge as such and in combination with the technologies referred to in Article 16, paragraph 1. It shall also, where feasible, include repatriation of information.

Article 18. Technical and Scientific Cooperation

1. The Contracting Parties shall promote international technical and scientific cooperation in the field of conservation and sustainable use of biological diversity, where necessary, through the appropriate international and national institutions.

2. Each Contracting Party shall promote technical and scientific cooperation with other Contracting Parties, in particular developing countries, in implementing this Convention, *inter alia*, through the development and implementation of national policies. In promoting such cooperation, special attention should be given to the development and strengthening of national capabilities, by means of human resources development and institution building.

3. The Conference of the Parties, at its first meeting, shall determine how to establish a clearing-house mechanism to promote and facilitate technical and scientific cooperation.

4. The Contracting Parties shall, in accordance with national legislation and policies, encourage and develop methods of cooperation for the development and use of technologies, including indigenous and traditional technologies, in pursuance of the objectives of this Convention. For this purpose, the Contracting Parties shall also promote cooperation in the training of personnel and exchange of experts.

5. The Contracting Parties shall, subject to mutual agreement, promote the establishment of joint research programmes and joint ventures for the development of technologies relevant to the objectives of this Convention.

Article 19. Handling of Biotechnology and Distribution of its Benefits

1. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, to provide for the effective participation in biotechnological research activities by those Contracting Parties, especially developing countries, which provide the genetic resources for such research, and where feasible in such Contracting Parties.

2. Each Contracting Party shall take all practicable measures to promote and advance priority access on a fair and equitable basis by Contracting Parties, especially developing countries, to the results and benefits arising from biotechnologies based upon genetic resources provided by those Contracting Parties. Such access shall be on mutually agreed terms.

3. The Parties shall consider the need for and modalities of a protocol setting of appropriate procedures, including, in particular, advance informed agreement, in the field of the safe transfer, handling and use of any

living modified organism resulting from biotechnology that may have adverse effect on the conservation and sustainable use of biological diversity.

4. Each Contracting Party shall, directly or by requiring any natural or legal person under its jurisdiction providing the organisms referred to in paragraph 3 above, provide any available information about the use and safety regulations required by that Contracting Party in handling such organisms, as well as any available information on the potential adverse impact of the specific organisms concerned to the Contracting Party into which those organisms are to be introduced.

Article 20. Financial Resources

1. Each Contracting Party undertakes to provide, in accordance with its capabilities, financial support and incentives in respect of those national activities which are intended to achieve the objectives of this Convention, in accordance with its national plans, priorities and programmes.

2. The developed country Parties shall provide new and additional financial resources to enable developing country Parties to meet the agreed full incremental costs to them of implementing measures which fulfil the obligations of this Convention and to benefit from its provisions and which costs are agreed between a developing country Party and the institutional structure referred to in Article 21, in accordance with policy, strategy, programme priorities and eligibility criteria and an indicative list of incremental costs established by the Conference of the Parties. Other Parties, including countries undergoing the process of transition to a market economy, may voluntarily assume the obligations of the developed country Parties. For the purpose of this Article, the Conference of the Parties, shall at its first meeting establish a list of developed country Parties and other Parties which voluntarily assume the obligations of the developed country Parties. The Conference of the Parties shall periodically review and if necessary amend the list. Contributions from other countries and sources on a voluntary basis would also be encouraged. The implementation of these commitments shall take into account the need for adequacy, predictability and timely flow of funds and the importance of burden-sharing among the contributing Parties included in the list.

3. The developed country Parties may also provide, and developing country Parties avail themselves of, financial resources related to the implementation of this Convention through Bilateral, regional and other multilateral channels.

4. The extent to which developing country Parties will effectively implement their commitments under this Convention will depend on the effective implementation by developed country Parties of their commitments under this Convention related to financial resources and transfer of technology and will take fully into account the fact that economic and social development and eradication of poverty are the first and overriding priorities of the developing country Parties.

5. The Parties shall take full account of the specific needs and special situation of least developed countries in their actions with regard to funding and transfer of technology.

6. The Contracting Parties shall also take into consideration the special conditions resulting from the dependence on, distribution and location of, biological diversity within developing country Parties, in particular small island States.

7. Consideration shall also be given to the special situation of developing countries, including those that are most environmentally vulnerable, such as those with arid and semi-arid zones, coastal and mountainous areas.

Article 21. Financial Mechanism

1. There shall be a mechanism for the provision of financial resources to developing country Parties for purposes of this Convention on a grant or concessional basis the essential elements of which are described in

this Article. The mechanism shall function under the authority and guidance of, and be accountable to, the Conference of the Parties for purposes of this Convention. The operations of the mechanism shall be carried out by such institutional structure as may be decided upon by the Conference of the Parties at its first meeting. for purposes of this Convention, the Conference of the Parties shall determine the policy, strategy, programme priorities and eligibility criteria relating to the access to and utilization of such resources. The contributions shall be such as to take into account the need for predictability, adequacy and timely flow of funds referred to in Article 20 in accordance with the amount of resources needed to be decided periodically be the Conference of the Parties and the importance of burden-sharing among the contributing Parties included in the list referred to in Article 20, paragraph 2. Voluntary contributions may also be made by the developed country Parties and by other countries and sources. The mechanism shall operate within a democratic and transparent system of governance.

2. Pursuant to the objectives of this Convention, the Conference of the Parties shall at its first meeting determine the policy, strategy and programme priorities, as well as detailed criteria and guidelines for eligibility for access to and utilization of the financial resources including monitoring and evaluation on a regular basis of such utilization. The conference of the Parties shall decide on the arrangements to give effect to paragraph 1 above after consultation with the institutional structure entrusted with the operation of the financial mechanism.

3. The Conference of the Parties shall review the effectiveness of the mechanism established under this Article, including the criteria and guidelines referred to in paragraph 2 above, not less than two years after the entry into force of this Convention and thereafter on a regular basis. Based on such review, it shall take appropriate action to improve the effectiveness of the mechanism if necessary.

4. The Contracting Parties shall consider strengthening existing financial institutions to provide financial resources for the conservation and sustainable use of biological diversity.

Article 22. Relationship with Other International Conventions

1. The provisions of this Convention shall not affect the rights and obligations of any Contracting Party deriving from any existing international agreement, except where the exercise of those rights and obligations would cause a serious damage or threat to biological diversity.

2. Contracting Parties shall implement this Convention with respect to the marine environment consistently with the rights and obligations of States under the law of the sea.

Article 23. Conference of the Parties

1. A Conference of the Parties is hereby established. The first meeting of the Conference of the Parties shall be convened by the Executive Director of the United Nations Environment Programme not later than one year after the entry into force of this Convention. Thereafter, ordinary meetings of the Conference of the Parties shall be held at regular intervals to be determined by the Conference at its first meeting.

2. Extraordinary meetings of the Conference of the Parties shall be held at such other times as may be deemed necessary by the Conference, or at the written request of any Party, provided that, within six months of the request being communicated to them by the Secretariat, it is supported by at least one third of the Parties.

3. The Conference of the Parties shall by consensus agree upon and adopt rules of procedure for itself and for any subsidiary body it may establish, as well as financial rules governing the funding of the Secretariat. At each ordinary meeting, it shall adopt a budget for the financial period until the next ordinary meeting.

4. The Conference of the Parties shall keep under review the implementation of this Convention, and, for this purpose, shall:

a) Establish the form and the intervals for transmitting the information to be submitted in accordance with Article 26 and consider such information as well as reports submitted by any subsidiary body;
b) Review scientific, technical and technological advice on biological diversity provided in accordance with Article 25;
c) Consider and adopt, as required, protocols in accordance with Article 28;
d) Consider and adopt, as required, in accordance with Articles 29 and 30, amendments to this Convention and its annexes;
e) Consider amendments to any protocol, as well as to any annexes thereto, and, if so decided, recommend their adoption to the parties to the protocol concerned;
f) Consider and adopt, as required, in accordance with Article 30, additional annexes to this Convention;
g) Establish such subsidiary bodies, particularly to provide scientific and technical advice, as are deemed necessary for the implementation of this Convention;
h) Contact, through the Secretariat, the executive bodies of conventions dealing with matters covered by this Convention with a view to establishing appropriate forms of cooperation with them; and
i) Consider and undertake any additional action that may be required for the achievement of the purposes of this Convention in the light of experience gained in its operation.

5. The United Nations, its specialized agencies and the International Atomic Energy Agency, as well as any State not Party to this Convention, may be represented as observers at meetings of the Conference of the Parties. Any other body or agency, whether governmental or non-governmental, qualified in fields relating to conservation and sustainable use of biological diversity, which has informed the Secretariat of its wish to be represented as an observer at a meeting of the Conference of the Parties, may be admitted unless at least one third of the Parties present object. The admission and participation of observers shall be subject to the rules of procedure adopted by the Conference of the Parties.

Article 24. Secretariat

1. A secretariat is hereby established. Its functions shall be:
a) To arrange for and service meetings of the Conference of the Parties provided for in Article 23;
b) To perform the functions assigned to it by any protocol;
c) To prepare reports on the execution of its functions under this Convention and present them to the Conference of the Parties;
d) To coordinate with other relevant international bodies and, in particular to enter into such administrative and contractual arrangements as may be required for the effective discharge of its functions; and
e) To perform such other functions as may be determined by the Conference of the Parties.

2. At its first ordinary meeting, the Conference of the Parties shall designate the secretariat from amongst those existing competent international organizations which have signified their willingness to carry out the secretariat functions under this Convention.

Article 25. Subsidiary Body on Scientific, Technical and Technological Advice

1. A subsidiary body for the provision of scientific, technical and technological advice is hereby established to provide the Conference of the Parties and, as appropriate, its other subsidiary bodies with timely advice relating to the implementation of this Convention. This body shall be open to participation by all Parties and shall be multidisciplinary. It shall comprise government representatives competent in the relevant field of expertise. It shall report regularly to the Conference of the Parties on all aspects of its work.

2. Under the authority of and in accordance with guidelines laid down by the Conference of the Parties, and upon its request, this body shall:
a) Provide scientific and technical assessments of the status of biological diversity;
b) Prepare scientific and technical assessments of the effects of types of measures taken in accordance with the

provisions of this Convention;
c) Identify innovative, efficient and state-of-the-art technologies and know-how relating to the conservation and sustainable use of biological diversity and advise on the ways and means of promoting development and/or transferring such technologies;
d) Provide advice on scientific programmes and international cooperation in research and development related to conservation and sustainable use of biological diversity; and
e) Respond to scientific, technical, technological and methodological questions that the Conference of the Parties and its subsidiary bodies may put to the body.

3. The functions, terms of reference, organization and operation of this body may be further elaborated by the Conference of the Parties.

Article 26. Reports

Each Contracting Party shall, at intervals to be determined by the Conference of the Parties, present to the Conference of the Parties, reports on measures which it has taken for the implementation of the provisions of this Convention and their effectiveness in meeting the objectives of the Convention.

Article 27. Settlement of Disputes

1. In the event of a dispute between Contracting Parties concerning the interpretation or application of this Convention, the parties concerned shall seek solution by negotiation.

2. If the parties concerned cannot reach agreement by negotiation, they may jointly seek the good offices of, or request mediation by, a third party.

3. When ratifying, accepting, approving or acceding to this Convention, or at any time thereafter, a State or regional economic integration organization may declare in writing to the Depositary that for a dispute not resolved in accordance with paragraph 1 or paragraph 2 above, it accepts one or both of the following means of dispute settlement as compulsory:
a) Arbitration in accordance with the procedure laid down in Part 1 of Annex II;
b) Submission of the dispute to the International Court of Justice.

4. If the parties to the dispute have not, in accordance with paragraph 3 above, accepted the same or any procedure, the dispute shall be submitted to conciliation in accordance with Part 2 of Annex II unless the parties otherwise agree.

5. The provisions of this Article shall apply with respect to any protocol except as otherwise provided in the protocol concerned.

Article 28. Adoption of Protocols

1. The Contracting Parties shall cooperate in the formulation and adoption of protocols to this Convention.

2. Protocols shall be adopted at a meeting of the Conference of the Parties.

3. The text of any proposed protocol shall be communicated to the Contracting Parties by the Secretariat at least six months before such a meeting.

Article 29. Amendment of the Convention of Protocols

1. Amendments to this convention may be proposed by any Contracting Party. Amendments to any protocol may be proposed by any Party to that protocol.

2. Amendments to this Convention shall be adopted at a meeting of the Conference of the Parties. Amendments to any protocol shall be adopted at a meeting of the Parties to the Protocol in question. The text of any proposed amendment to this Convention or to any protocol, except as may otherwise be provided in such protocol, shall be communicated to the Parties to the instrument in question by the secretariat at least six months before the meeting at which it is proposed for adoption. The secretariat shall also communicate proposed amendments to the signatories to this Convention for information.

3. The Parties shall make every effort to reach agreement on any proposed amendment to this Convention or to any protocol by consensus. If all efforts at consensus have been exhausted, and no agreement reached, the amendment shall as a last resort be adopted by a two-third majority vote of the Parties to the instrument in question present and voting at the meeting, and shall be submitted by the Depositary to all Parties for ratification, acceptance or approval.

4. Ratification, acceptance or approval of amendments shall be notified to the Depositary in writing. Amendments adopted in accordance with paragraph 3 above shall enter into force among Parties having accepted them on the ninetieth day after the deposit of instruments of ratification, acceptance or approval by at least two-thirds of the Contracting Parties to this Convention or of the Parties to the protocol concerned, except as may otherwise be provided in such protocol. Thereafter the amendments shall enter into force for any other Party on the ninetieth day after that Party deposits its instrument of ratification, acceptance or approval of the amendments.

5. For the purposes of this Article, "Parties present and voting" means Parties present and casting an affirmative or negative vote.

Article 30. Adoption and Amendment of Annexes

1. The annexes to this Convention or to any protocol shall form an integral part of the Convention or of such protocol, as the case may be, and, unless expressly provided otherwise, a reference to this Convention or its protocols constitutes at the same time a reference to any annexes thereto. Such annexes shall be restricted to procedural, scientific, technical and administrative matters.

2. Except as may be otherwise provided in any protocol with respect to its annexes, the following procedure shall apply to the proposal, adoption and entry into force of additional annexes to this Convention or of annexes to any protocol:

a) Annexes to this Convention or to any protocol shall be proposed and adopted according to the procedure laid down in Article 29;
b) Any Party that is unable to approve an additional annex to this Convention or an annex to any protocol to which it is Party shall so notify the Depositary, in writing, within one year from the date of the communication of the adoption by the Depositary. The Depositary shall without delay notify all Parties of any such notification received. A Party may at any time withdraw a previous declaration of objection and the annexes shall thereupon enter into force for that Party subject to subparagraph (c) below;
c).On the expiry of one year from the date of the communication of the adoption by the Depositary, the annex shall enter into force for all Parties to this Convention or to any protocol concerned which have not submitted a notification in accordance with the provisions of subparagraph (b) above.

3. The proposal, adoption and entry into force of amendments to annexes to this Convention or to any protocol shall be subject to the same procedure as for the proposal, adoption and entry into force of annexes to the Convention or annexes to any protocol.

4. If an additional annex or an amendment to an annex is related to an amendment to this Convention or to any protocol, the additional annex or amendment shall not enter into force until such time as the amendment to the Convention or to the protocol concerned enters into force.

Article 31. Right to Vote

1. Except as provided for in paragraph 2 below, each Contracting Party to this Convention or to any protocol shall have one vote.

2. Regional economic integration organizations, in matters within their competence, shall exercise their right to vote with a number of votes equal to the number of their member States which are Contracting Parties to this Convention or the relevant protocol. Such organizations shall not exercise their right to vote if their member States exercise theirs, and vice versa.

Article 32. Relationship between this Convention and Its Protocols

1. A State or a regional economic integration organization may not become a Party to a protocol unless it is, or becomes at the same time, a Contracting Party to this Convention.

2. Decisions under any protocol shall be taken only by the Parties to the protocol concerned. Any Contracting Party that has not ratified, accepted or approved a protocol may participate as an observer in any meeting of the parties to that protocol.

Article 33. Signature

This Convention shall be open for signature at Rio de Janeiro by all States and any regional economic integration organization from 5 June, 1992, until 14 June, 1992, and at the United Nations Headquarters in New York from 15 June, 1992, to 4 June, 1993.

Article 34. Ratification, Acceptance or Approval

1. This Convention and any protocol shall be subject to ratification, acceptance or approval by States and by regional economic integration organizations. Instruments of ratification, acceptance or approval shall be deposited with the Depositary.

2. Any organization referred to in paragraph 1 above which becomes a Contracting Party to this Convention or any protocol without any of its member States being a Contracting Party shall be bound by all the obligations under the Convention or the protocol, as the case may be. In the case of such organizations, one or more of whose member States is a Contracting Party to this Convention or relevant protocol, the organization and its member States shall decide on their respective responsibilities for the performance of their obligations under the Convention or protocol, as the case may be. In such cases, the organization and the member States shall not be entitled to exercise rights under the Convention or relevant protocol concurrently.

3. In their instruments of ratification, acceptance or approval, the organizations referred to in paragraph 1 above shall declare the extent of their competence with respect to the matters governed by the Convention or the relevant protocol. These organizations shall also inform the Depositary of any relevant modification in the extent of their competence.

Article 35. Accession

1. This Convention and any protocol shall be open for accession by States and by regional economic integration organizations from the date on which the Convention or the protocol concerned is closed for signature. The instruments of accession shall be deposited with the Depositary.

2. In their instruments of accession, the organizations referred to in paragraph 1 above shall declare the exten of their competence with respect to the matters governed by the Convention or the relevant protocol. Thes organizations shall also inform the Depositary of any relevant modification in the extent of their competence.

3. The provisions of Article 34, paragraph 2, shall apply to regional economic integration organizations wnich accede to this Convention or any protocol.

Article 36. Entry Into Force

1. This Convention shall enter into force on the ninetieth day after the date of deposit of the thirtieth instrument of ratification, acceptance, approval or accession.

2. Any protocol shall enter into force on the ninetieth day after the date of deposit of the number of instruments of ratification, acceptance, approval or accession, specified in that protocol, has been deposited.

3. For each Contracting Party which ratifies, accepts or approves this Convention or accedes thereto after the deposit of the thirtieth instrument of ratification, acceptance, approval or accession, it shall enter into force on the ninetieth day after the date of deposit by such Contracting Party of its instrument of ratification, acceptance, approval or accession.

4. Any protocol, except as otherwise provided in such protocol, shall enter into force for a Contracting Party that ratifies, accepts or approves that protocol or accedes thereto after its entry into force pursuant to paragraph 2 above, on the ninetieth day after the date on which that Contracting Party deposits its instrument of ratification, acceptance, approval or accession, or on the date on which this Convention enters into force for the Contracting Party, whichever shall be the later.

5. For the purposes of paragraphs 1 and 2 above, any instrument deposited by a regional economic integration organization shall not be counted as additional to those deposited by member States of such organization.

Article 37. Reservations

No reservations may be made to this Convention.

Article 38. Withdrawals

1. At any time after two years from the date on which this Convention has entered into force for a Contracting Party, that Contracting Party may withdraw from the Convention by giving written notification to the Depositary.

2. Any such withdrawal shall take place upon expiry of one year after the date of its receipt by the Depositary, or on such later date as may be specified in the notification of the withdrawal.

3. Any Contracting Party which withdraws from this Convention shall be considered as also having withdrawn from any protocol to which it is party.

Article 39. Financial Interim Arrangements

Provided that it has been fully restructured in accordance with the requirements of Article 21, the Global Environment Facility of the the United Nations Development Programme, the United Nations Environment Programme and the International Bank for Reconstruction and Development shall be the institutional structure referred to in Article 21 on an interim basis, for the period between the entry into force of this Convention and the first meeting of the Conference of the Parties or until the Conference of the Parties decides which institutional structure will be designated in accordance with Article 21.

Article 40. Secretariat Interim Arrangements

The secretariat to be provided by the Executive Director of the United Nations Environment Programme shall

be the secretariat referred to in Article 24, paragraph 2, on an interim basis for the period between the entry into force of this Convention and the first meeting of the Conference of the Parties.

Article 41. Depositary

The Secretary-General of the United Nations shall assume the functions of Depositary of this Convention and any protocols.

Article 42. Authentic Texts

The original of this Convention, of which Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

IN WITNESS WHEREOF the undersigned, being duly authorized to that effect, have signed this Convention. Done at Rio de Janeiro on this fifth day of June, one thousand nine hundred and ninety-two.

Annex I

Identification and Monitoring

1. Ecosystems and habitats: containing high diversity, large numbers of endemic or threatened species, or wilderness; required by migratory species; of social, economic, cultural or scientific importance; or which are representative, unique or associated with key evolutionary or other biological processes;

2. Species and communities which are: threatened; wild relative of domesticated or cultivated species; of medicinal, agriculture or other economic value; or social, scientific or cultural importance; or importance for research into the conservation and sustainable use of biological diversity, such as indicator species; and

3. Described genomes and genes of social, scientific or economic importance.

Annex II

Part 1 Arbitration

Article 1

The claimant party shall notify the secretariat that the parties are referring a dispute to arbitration pursuant to Article 27. The notification shall state the subject-matter of arbitration and include, in particular, the articles of the Convention or the protocol, the interpretation or application of which are at issue. If the parties do not agree on the subject matter of the dispute before the President of the tribunal is designated, the arbitral tribunal shall determine the subject matter. The secretariat shall forward the information thus received to all Contracting Parties to this Convention or to the protocol concerned.

Article 2

1. In disputes between two parties, the arbitral tribunal shall consist of three members. Each of the parties to the dispute shall appoint an arbitrator and the two arbitrators so appointed shall designate by common agreement the third arbitrator who shall be the President of the tribunal. The letter shall not be a national of one of the parties to the dispute, nor have his or her usual place of residence in the territory of one of these parties, nor be employed by any of them, nor have dealt with the case in any other capacity.

2. In disputes between more than two parties, parties in the same interest shall appoint one arbitrator jointly by agreement.

3. Any vacancy shall be filled in the manner prescribed for the initial appointment.

Article 3

1. If the President of the arbitral tribunal has not been designated within two months of the appointment of the second arbitrator, the Secretary-General of the United Nations shall, at the request of a party, designate the President within a further two-month period.

2. If one of the parties to the dispute does not appoint an arbitrator within two months of receipt of the request, the other party may inform the Secretary-General who shall make the designation within a further two-month period.

Article 4

The arbitral tribunal shall render its decisions in accordance with the provisions of this Convention, any protocols concerned, and international law.

Article 5

Unless the parties to the dispute otherwise agree, the arbitral tribunal shall determine its own rules of procedure.

Article 6

The arbitral tribunal may, at the request of one of the parties, recommend essential interim measures of protection.

Article 7

The parties to the dispute shall facilitate the work of the arbitral tribunal and, in particular, using all means at their disposal, shall:

a) Provide it with all relevant documents, information and facilities; and

b) Enable it, when necessary, to call witnesses or experts and receive their evidence.

Article 8

The parties and the arbitrators are under an obligation to protect the confidentiality of any information they receive in confidence during the proceedings of the arbitral tribunal.

Article 9

Unless the arbitral tribunal determines otherwise because of the particular circumstances of the case, the costs of the tribunal shall be borne by the parties to the dispute in equal shares. The tribunal shall keep a record of all its costs, and shall furnish a final statement thereof to the parties.

Article 10

Any Contracting Party that has an interest of a legal nature in the subject-matter of the dispute which may be affected by the decision in the case, may intervene in the proceedings with the consent of the tribunal.

Article 11

The tribunal may hear and determine counterclaims arising directly out of the subject-matter of the dispute.

Article 12

Decisions both on procedure and substance of the arbitral tribunal shall be taken by a majority vote of its members.

Article 13

If one of the parties to the dispute does not appear before the arbitral tribunal or fails to defend its case, the other party may request the tribunal to continue the proceedings and to make its award. Absence of a party or a failure of a party to defend its case shall not constitute a bar to the proceedings. Before rendering its final decision, the arbitral tribunal must satisfy itself that the claim is well founded in fact and law.

Article 14
The tribunal shall render its final decision within five months of the date on which it is fully constituted unless it finds it necessary to extend the time-limit for a period which should not exceed five more months.

Article 15
The final decision of the arbitral tribunal shall be confined to the subject-matter of the dispute and shall state the reasons on which it is based. It shall contain the names of the members who have participated and the date of the final decision. Any member of the tribunal may attach a separate or dissenting opinion to the final decision.

Article 16
The award shall be binding on the parties to the dispute. It shall be without appeal unless the parties to the dispute have agreed in advance to an appellate procedure.

Article 17
Any controversy which may arise between the parties to the dispute as regards the interpretation or manner of implementation of the final decision may be submitted by either party for decision to the arbitral tribunal which rendered it.

Part 2 Conciliation

Article 1
A conciliation commission shall be created upon the request of one of the parties to the dispute. The commission shall, unless the parties otherwise agree, be composed of five members, two appointed by each Party concerned and a President chosen jointly by those members.

Article 2
In disputes between more than two parties, parties in the same interest shall appoint their members of the commission jointly by agreement. Where two or more parties have separate interests or there is a disagreement as to whether they are of the same interest, they shall appoint their members separately.

Article 3
If any appointments by the parties are not made within two months of the date of the request to create a conciliation commission, the Secretary-General of the United Nations shall, if asked to do so by the party that made the request, make those appointments within a further two-month period.

Article 4
If a President of the conciliation commission has not been chosen within two months of the last of the members of the commission being appointed, the Secretary-General of the United Nations shall, if asked to do so by a party, designate a President within a further two-month period.

Article 5
The conciliation commission shall take its decisions by majority vote of its members. It shall, unless the parties to the dispute otherwise agree, determine its own procedure. It shall render a proposal for resolution of the dispute, which the parties shall consider in good faith.

Article 6
A disagreement as to whether the conciliation commission has competence shall be decided by the commission.

ICSU Statement on Gene Patenting

Paris, June 1992

The International Council of Scientific Unions (ICSU) is an international non-governmental organization whose mandate includes the promotion of cooperation in the basic sciences, and the safeguarding of the principle of the universality of science of of the free flow of scientific knowledge.

The Council is aware of the tremendous potential benefit of genetic research for humanity and realizes that new ethical and social dimensions arise from this. Accordingly, ICSU strongly believes that efforts to patent genetic information should not jeopardize either progress in the basic sciences or access to the information which is necessary for such progress to continue.

ICSU asserts its view that information about nucleic acid sequences cannot be patented *per se*. Such sequences should be patentable solely within the context of their demonstrated significance and/or application (*e.g.*, regulatory signals, antisense RNAs, probes, etc.) -- and not of their potential products (e.g., proteins) -- and provided that this can be shown to be "novel", "non-obvious" and "useful".

Under such circumstances, patenting of complementary DNA sequences (cDNAs) would distort the patent process, which is designed to protect applications, methods, and products, on the basis of proven facts and not mere expectations, and normally serves society by stimulating the investments and developments necessary to provide useful products and services. Any deviation from such patenting principles would run counter to the best interests of science and hinder international collaboration in such endeavours. ICSU therefore cautions against decisions which may be irreversible, such as those possibly emerging as a result of the recent patent requests concerning complementary DNA (cDNA) sequences corresponding to portions of unknown messenger RNAs (mRNA).

ICSU urges the relevant authorities, particularly in countries where patent applications in this field have been or are soon to be filed, to consider such applications taking due account of the possible implications and to ensure a strict application of established patenting principles, thereby setting an example for other countries in which similar cases may arise in the future.

ICSU would welcome a formal international agreement on this subject.

Tyler Prize

Call for Nominations

Citizens of all nations are invited to nominate individual scientists or scientific institutions of any nation. Those eligible for nominations should include, but are not limited to:

Scientists in fields such as biology, oceanography, geology, chemistry and physics; engineers in fields such as civil, environmental, petroleum and chemical engineering; and social scientists in fields such as geography, political science, economics and law;

National academies of science, engineering or their equivalent, and their members;

Universities, research institutions and their members;

National and international science, health, environment and development organizations.

The deadline for the US$150 000 award must be received no later than 1 October, 1992. Related credentials, supporting material and letters of reference must be received no later than 15 October. The nomination should be mailed to: Dr. Jerome B. Walker, Executive Director, The Tyler Prize, Office of the Provost, University of Southern California, Los Angeles, CA 90089-4019, U.S.A. (Fax: (213) 740 1313).

XVTH International Botanical Congress

The Organizing Committee of the 15th International Botanical Congress (XVth IBC) wishes to invite international societies in the botanical and mycological sciences to hold either their general and/or committee meetings during the Congress period of 28 August to 3 September, 1993, in Kyoto, Japan.

Notification should be sent to Professor Kunio Iwatusuki, Secretary XVth IBC, c/o Botanical Gardens, University of Tokyo, 3-7-1 Hakusan, Bunkyo-ku, Tokyo 112, Japan (Fax: (81.3) 3814 0139) before 30 October, 1992. The following information should be included:

(1) name of organization and meeting, contact person's name and address;
(2) number of expected participants;
(3) dates of meeting;
(4) equipment needed (i.e., projectors, OHP, etc.);
(5) any other special requests.

The Congress site, Pacifico Yokohama, has a limited number of rooms available, and is kindly requested that Professor Iwatsuki is contacted as soon as possible.

International Symposium on "Environmental Information Management and Analysis: Ecosystem to Global Scales"

CALL FOR PAPERS

May 20-22, 1993
Albuquerque, New Mexico, USA

Sponsored by the National Science Foundation, USA.

Background

The symposium will provide an international forum for exchange of information and technology among computer scientists, Geographic Information System/Research Data-Information Management specialists, and environmental scientists (atmospheric, marine, freshwater, terrestrial) engaged in scientific database development, management of complex long-term and broad scale databases, and addressing questions at ecosystem through global scales. The symposium will be organized along four related themes:

(1) Ecosystem, Regional, Continental, and Global Scale Research

(2) Scientific Databases for Long-Term and Broad-Scale Research: Design and Development, Management, and Quality Assurance/ Quality Control

(3) Analytical Approaches for Addressing Questions at Ecosystem to Global Scales

(4) Development, Management, and Analysis of Databases Designed to Address Ecosystem, Regional, Continental , and Global Environmental Issues: Case Histories

Call for Papers

Authors are invited to submit papers related to one of the four themes. Limited financial support for travel, lodging, and symposium expenses will be available.

For additional information contact (email is most direct):

Susan Stafford
Forest Science Department
Oregon State University
Peavy Hall 154
Corvallis, OR 97331-5705, USA

Telephone: 503-737-6581
Fax : 503-737-1393
Internet: stafford a fsl.orst.edu
BITNET: sstafford a Iternet

William Michener
Baruch Institute
University of South Carolina
Columbia, SC 29208

Telephone: 803-777-3926
Fax : 803-777-3935
Internet: wmichener a Iternet.washington.edu
BITNET: wmichener a Iternet

IUBS Financial Statement for the Year 1991

STATEMENT 1. Balance sheet at December 31, 1991 (Expressed in US$)

ASSETS: ***Cash and Banks***			
Crédit Lyonnais, Paris			
in US$	57 327		
in FF	98 311		
in US$			
(Deposit Account)	200 000	*355 638*	
Merril Lynch, New York (in US$)	395 268	*395 268*	
750 906			
LESS: ***Liabilities***			
Sundry creditors	11 977	*11 977*	
Excess of assets over liabilities			**738 929**
Represented by accumulated fund			**738 929**

STATEMENT 2. Income and Expenditure for the year ended December 31, 1991 (Expressed in US$)

1. INCOME			
ICSU Subventions	26 500		
Special Subventions from International Organisations	448 478		
Contributions from National Members	280 288		
Interests and dividends	43 541		
Gain on Exchange	1 069		
Other Income	20 265		
TOTAL INCOME			**820 141**
2. EXPENDITURE			
Business Meetings			
General Assembly, Executive Committee Meetings & Officers' meetings and travels	40 744	*40 744*	
Publications	8 481	*8 481*	
Scientific Programmes and Activities			
Grants to IUBS Scientific Programmes	407 749		
Representation at scientific meetings	8 104		
Contribution to other Organisations	6 240		
Scientific Activities of IUBS Scientific Members	43 135	*465 228*	
Administrative Expenses			
Salaries	86 983		
Related charges	82 058		
General office expenses	46 493		
Bank charges & Loss over Exchange	390		
Audit fees	3 942	*219 866*	
TOTAL EXPENDITURE			**734 319**
Excess/Loss of Income over Expenditure			**85 822**
Accumulated balance carried forward			**738 929**

PUBLICATIONS REVIEW

THE BIODIVERSITY OF MICRO-ORGANISMS AND INVERTEBRATES
Its Role in Sustainable Agriculture

Edited by D. L. Hawksworth
CASAFA Report Series N° 4, published by C.A.B. International, 1991 (302 pages)

This book is based on a workshop organized by CAB International in association with the ICSU Committee on the Application of Science to Agriculture, Forestry and Aquaculture (CASAFA) and the Third World Academy of Sciences (TWAS). It represents a major contribution to the current debate on the implications of declining biodiversity for sustainable agricultural production and environmental protection, particularly the importance of microorganisms and invertebrates in the stable functioning of ecosystems, maintenance of soil fertility and provision of natural enemies for the biological control of pests and pathogens.

BIOINDICATORS AND ENVIRONMENTAL MANAGEMENT

Edited by D. W. Jeffrey & B. Madden.
Published by Academic Press, 1991 (458 pages).

Based on a meeting organized by the IUBS Commission of Bioindicators, this book aims to promote the use of bioindicators by bringing together the latest reports of on-going monitoring schemes and new research drawn from a wide range of biological disciplines. Key features include the presentation of current developments in basic research in biomonitoring, and provides examples of practical applications of bioindicators in environmental management, their use in monitoring after-effects of nuclear accidents and monitoring long-term and large scale environmental trends.

BIOGEOGRAPHY OF MEDITERRANEAN INVASIONS

Edited by R. H. Groves & F. di Castri.
Published by Cambridge University Press, 1991 (485 pages).

This book, which is an initiative of the International Society of Mediterranean Ecologists (ISOMED) and a sub-committee of SCOPE, provides a unique documentation of the introduced floras and faunas in the Mediterranean Basin, California, Chile, the western Cape of South Africa and southern Australia. These five regions have different patterns of human settlement but similarities in natural vegetation and faunal assemblages. This publication increases our understanding of the ecology of biological invasions and points the way to more effective management of the biota of these regions.

BIOLOGICAL INVASIONS IN EUROPE AND THE MEDITERRANEAN BASIN

Edited by F. di Castri, A. J. Hansen & M. Debussche.
Published by Kluwer Academic Publishers, 1990 (463 pages).

Within the framework of the international synthesis on the ecology of biological invasions conducted by ICSU-SCOPE, this book focuses on Europe and the Mediterranean Basin, describing patterns of colonization of plants, animals and parasites during prehistoric and modern times. It also examines some mechanisms and consequences of biological invasions, and explores why Europe has produced so many New World colonists while remaining resistant to invasion.

LANDSCAPE BOUNDARIES
Consequences for Biotic Diversity and Ecological Flows

Edited by A. J. Hansen & F. di Castri.
Ecological Studies Series (N° 92) published by Springer Verlag, 1992 (452 pages).

This volume examines the effect of ecotones (transition zones between ecosystems) on community diversity and landscape functioning, and explores their role in controlling the flow of energy, material, and organisms between ecosystems. It synthesizes existing theory, evaluates central hypotheses relative to empirical and simulation data, and puts forth new hypotheses.

BRYOZOA LIVING AND FOSSIL

Edited by F. P. Bigey in collaboration with J-L. d'Hondt.
Published in «Bulletin de la Société des Sciences Naturelles de l'Ouest de la France, Mémoire HS 1, Nantes», 1991 (599 pages).

This volume consists of the proceedings of the 8th International Bryozoology Conference, held in Paris, July 1989. 77 papers were presented in sessions arranged to encourage discussions among paleontologists and biologists, e.g. taxonomy, evolution and phylogeny, sedimentary environment. New concepts have been developed for the taxonomic study of Paleozoic and Recent forms.

CONSERVATION OF BIODIVERSITY FOR SUSTAINABLE DEVELOPMENT

Edited by O. T. Sandlund, K. Hindar & A. H. D. Brown.
Published by Scandinavian University Press, 1992 (324 pages).

This volume is the result and discussions at the International Conference on Conservation of Genetic Resources for Sustainable Development, which was organized by the Norwegian Institute for Nature Research (NINA) and held at Roros, Norway, on 10-14 September, 1990. The authors discuss conservation from various perspectives of genetics, ecology, economics, politics, ethics and philosophy, and underlines the necessity of a multi-disciplinary approach to achieve a sustainable management of Earth's living resources. The book concludes with three sets of recommendations for action in biodiversity conservation, aimed at policy makers, managers and administrators, and researchers.

MAMMALS IN THE PALAEARCTIC DESERT
Status and Trends in the Sahara-Gobian Region

Edited by J. A. McNeely & V. M. Neronov.
Published by the Russian Academy of Sciences and the Russian Committee for the UNESCO Man and Biosphere (MAB) Programme, 1991 (297 pages).

This volume consists of the proceedings of the symposium on «The Conservation of Rare and Endangered Mammal Species by the Biosphere Reserve Network in the Sahara-Gobian Desert Region», organized within the framework of the 5th International Theriological Congress (22-29 August, 1989, Rome, Italy). Papers were presented in two parts: the first discusses the various aspects related to the development of the network of protected areas and conservation of rare species of mammals in the Sahara-Gobian region, and the second provides some concrete and exceptionally interesting data on the status of conservation of rare and endangered species of mammals in some individual countries in the Great Desert Belt (North Africa, the Arabian Peninsula, India and Mongolia) .

TERRE, PATRIMOINE COMMUN

Sous la direction de Martine Barrère.
Published (in French and Portuguese) by La Découverte/Association Descartes, France, 1992 (192 pages).

This book includes papers by 30 scientists from all over the world, and aims to present to the policy makers and the general public as well, the major concerns and issues debated at the Rio Summit on Environment and Development. It

provides an overview of the state of knowledge and future prospects concerning the environment, oceans and climate, global change, soil degradation, forest management, biotechnologies and the economic challenge for sustainable development. Also explored are potential avenues to promote North-South dialogue, bringing together their respective agendas concerning environment and development.

THE UNITY OF EVOLUTIONARY BIOLOGY

Edited by Elizabeth C. Dudley.
Published by Dioscorides Press (two volume set), 1991 (1048 pages).

These two volumes consist of the proceedings of the Fourth International Congress of Systematic and Evolutionary Biology, organized at the University of Maryland, College Park, USA, July 1990. They include 8 parts dealing with the following issues: biodiversity, evolution on islands, phylogenetic processes, morphology and development in evolution, population and community evolution, symbiosis and coevolution, genetic processes in evolution, cellular and molecular levels of evolution, and methods and resources.

LONG-TERM MONITORING OF BIOLOGICAL DIVERSITY IN TROPICAL FORESTS AREAS: Methods for Establishment and Inventory of Permanent Plots

Edited by F. Dallmeier.
Published by UNESCO MAB DIGEST N°11, 1992 (72 pages).

This MAB Digest describes methods for establishing and maintaining permanent inventory plots in tropical forests, with emphasis on sites designated as biosphere reserves. Underlying aims are to facilitate the documented inventory of plant diversity and to provide long-term data on growth, mortality, regeneration and dynamics of forest trees. As such, the approach and methods set out in this digest are intended to support the development of an information base for research and education that will contribute to the conservation and management of biosphere reserves and other protected areas throughout the world and to the monitoring of long-term environmental change.

ECOLOGIE DES PEUPLEMENTS Structure, dynamique et évolution

By R. Barbault.
Published (in French) by Masson, Paris, 1992 (273 pages).

This book presents an integrated approach for understanding ecosystem dynamics and population ecology. The first part deals with the concepts of populations and communities, and the methods to study the characteristics of communities, their functioning and the dynamical aspect and historical dimension of ecological problems.

The second part is devoted to the study of ecological niches and resources, resource partitioning, and the potential role of interspecific competition and guild organisation. The third part focuses on spatial heterogeneity and temporal variability and communities, and the community dynamics in a complex and heterogeneous environment.

This book concludes with a review of the future prospects linking community ecology and the current issues of biodiversity, conservation biology and global change.

IUBS

RECENT PUBLICATIONS

BIOLOGY INTERNATIONAL

Special Issues

N°19-Diversity of Tropical Species: Questions That Elude Answers, by A. Lugo. 1988(US$10)
N°20-Tropical Soil Biology and Fertility Programme: Report of VI TSBF Inter-regional Workshop, by M. J. Swift & J. S. I. Ingram.1989 (US$ 10)
N°21-Reproductive Ecology of Tropical Forest Plants, by K. Bawa *et al.* 1989 (US$ 10)
N°22-Ecosystem Function of Biological Diversity, by F. di Castri & T. Younés. 1990 (US$ 10)
N°23-Marine Biodiversity and Ecosystem Function, by J. F. Grassle *et al.* 1991 (US$ 15)
N°24-Savanna Modelling for Global Change, by O. Solbrig.1991 (US$ 15)
N°25-Soil Fertility and Global Change, by M.J. Swift. 1991 (US$ 15)
N°26-Reproductive Biology in Aquaculture, by P. van Oordt 1991 (US$ 15)
N°27-Inventorying and Monitoring Biodiversity, by F. di Castri, J. Robertson & T. Younés. 1992 (US$ 20)

IUBS MONOGRAPH SERIES

N°3- Determinants of Tropical Savannas, by B. H. Walker. 1987 (US$ 25)
N°5- Computers and Biological Education: The Expanding Universe, by T. Crovello. 1988 (US$25)
N°6- Perspectives on Biological Complexity, by O. T. Solbrig & G. Nicolis. 1991(US$ 30)
N°7- From Genes to Ecosystems: a Research Agenda for Biodiversity, by O. Solbrig. 1991 (US$ 30)
N°8- Biodiversity and Global Change, by O. Solbrig, H. van Emden & P. van Oordt. 1992 (US$ 30)

IUBS METHODOLOGY SERIES

N°1- Research Procedure and Experimental Design for Savanna Ecology and Management, by B.H. Walker and J-C. Menaut. 1988 (US$20)
N°2- Manual of Methods for Mountain Transect Studies, by T. van der Hammen, D. Mueller-Dombois & M. Little. 1989 (US$20)
N°3- TSBF- A Handbook of Methods, by J.M. Anderson & J.S.I. Ingram. 1989 (Published by C.A.B.International, Wallingford, Oxon OX10 8DE, UK)
N°4- Handbook of Methods for the Measurement of Work Performance, Physical Fitness and Energy Expenditure in Tropical Poulations, by K.J. Collins. 1990 (US$ 25)

PROCEEDINGS

Time Scales and Water Stress: Proceedings of the 5th Int'l Conf. on Mediterranean Ecosystems, by F. di Castri, Ch. Floret, S. Rambal, J. Roy, 1989 (US$ 70)
Promoting Life Sciences for a Better Human Life: the Proceedings of the 24rd IUBS General Assembly (1991) Amsterdam, Netherlands), by T. Younés, (US$25)

For information and requests please contact the IUBS Secretariat:
51, Bld de Montmorency, 75016 Paris, France

CALENDAR OF MEETINGS

IUBS meetings are indicated in bold types.
Additional information from addresses in parentheses.

MEETINGS 1992

APICULTURE
5th International Conference on Apiculture in Tropical Climates
7-12 Sept., Trinidad
(Nicola Bradbear, Conference Steering Committee IBRA, 18 North Road, Cardiff CF13DY, U.K.)

BIO-INDICATORS
7th International Bioindicators Symposium and Workshop on Environmental Health
28 Sept.-3 Oct., Kuopio, Finland
(S. Roy, Department of Physiology, University of Kuopio, P.O.Box 1627, 70211 Kuopio, Finland)

CELL BIOLOGY
Biology of Cartilage and Bone: Molecular and Cellular Aspects of Cartilage and Bone Differentiation
11-16 Nov., Le Bischenberg, France
(J. Hendekovic, European Science Foundation, 1 aui Lezay-Marnésia, 67080 Strasbourg Cedex, France)

CODATA
13th International Conference and 18th General Assembly
19-24 Oct., Beijing, China
(P. Glaeser, CODATA Secretariat, 51 blvd. de Montmorency, 75016 Paris, France)

CULTURE COLLECTIONS
International Congress of the World Federation of Culture Collections
Oct., Beijing, China
(Vanderlei P. Canhos, Sec. Gen. WFCC Fund. André Tosello, R. Latino Coelho 1301, Caixa Postal 1889, Campinas Q13 085, Brazil)

CYBERNETICS
13th International Congress on Cybernetics
24-28 Aug., Namur, Belgium
(International Association for Cybernetics, Palais des Expositions, Place André Rijckmans, B-5000 Namur, Belgium)

ECOLOGY
Directions: Ecology Towards the Year 2000
12-13 Nov., Parma, Italy
(P. Menozzi, Istituto di Ecologia, Università, Viale delle Scienze, 43100 Parma, Italy)

ESF
Mechanisms in Toxicity: the Biological Relevance of Molecular, Cellular and in vivo Models
10-15 Nov., San Feliu de Guixols, Spain
(J. Hendekovic, European Science Foundation, 1 aui Lezay-Marnésia, 67080 Strasbourg Cedex, France)

GENETICS
23rd International Animal Genetics Conference
3-7 Aug., Interlaken, Switzerland
(K. Bell, Secr. Gen., ISAG, Dept. of Physiology & Pharmacology, Univ. of Queensland, St. Lucia, Brisbane 4067, Australia)

HORTICULTURAL SCIENCE
International Symposium on Industrial Use of Bamboo

7-11 Dec., Beijing, China
(Zhu Shilin, Bamboo Information Centre, Chinese Academy of Forestry, Wan Shou Shan 100091, Beijing, China)

IMMUNOLOGY
8th International Congress of Immunology
23-28 Aug., Budapest, Hungary
(Congress Bureau, 8th Int'l Congress of Immunology, Intercongress Ltd., Dozsa Gy. ut 84/A, H-1068 Budapest, Hungary)

LABORATORY ANIMAL SCIENCE
ICLAS Regional Symposium
12-16 Oct., Beijing, China.
(Lu Yaozeng, Chinese Association for Laboratory Animal Science, 9 Dong Dan San Tiao, 100730, Beijing, China)

LIMNOLOGY
25th Congress of the Societas Internationalis Limnologiae

21-27 Aug., Barcelona, Spain
(OTAC, S.A. Sepulveda, 45-47 Pral., 08015, Barcelona, Spain)

MALACOLOGY
11th International Malacological Congress
30 Aug.-5 Sept., Siena, Italy
(Folco Giusti, Dipto. di Biologia Evolutiva, Univ. di Siena, Via Mattioli 4, I-53100 Siena, Italy)

MICROBIAL ECOLOGY
6th International Symposium on Microbial Ecology
6-11 Sept., Barcelona, Spain
(Prof. Ricardo Guerrero, ISME-6, Apartado 16009, E-08080 Barcelona, Spain)

MYCOLOGY
XI Congress of European Mycologists
7-11 Sept., Kew, UK
(D. N. Pegler, Royal Botanic Gardens, Kew, Surrey TW9 3AE, UK)

PALEONTOLOGY
IPA General Assembly & Council Meeting
Aug., Kyoto, Japan
(M. Kato, Dept. of Geology & Mineralogy, Faculty of Science, Hokkaido University, Sapporo 060, Japan)

PALYNOLOGY
8th International Palynological Congress
6-12 Sept., Aix-en Provence, France
(J.-P. Suc, Lab. de Palynologie, CNRS, Univ. des Sciences et Techniques du Languedoc, 34060 Montpellier cedex, France)

29th International Geological Congress
24 Aug.-3 Sept., Kyoto, Japan
(T. Sato, Chairman Japanese National Committee on Geology, Inst. of Geoscience, The Univ. of Tsukuba, Ibaraki, 305 Japan)

PARASITOLOGY
6th European Multi-colloquium of Parasitology (EMOP-6)
7-11 Sept., The Hague, the Netherlands
(F.van Knapen, Sec. Gen. World Federation of Parasitologists, Inst. for Health Research & Environmental Hygiene, P.O.Box 1, Bilthoven, NL-3720 BA, the Netherlands)

POLYCHAETES
4th International Polychaete Conference
summer, Angers, France
(D. Reish, Sec. Gen., IPA, Dept. Biology, California State Univ., Long Beach, CA 90840-3702, U.S.A.)

SEED TECHNOLOGY
23rd ISTA Congress
27 Oct.-7 Nov., Buenos Aires, Argentina
(ISTA Secretariat, B.P. 412, CH-8046 Zürich, Switzerland)

SOIL ZOOLOGY
11th International Soil Zoology Colloquium
10-14 Aug., Jyvaskyla, Finland
(K. Lee, CSIRO Division of Soils, P.O.B. 2, PO Glen Osmond, S.A. 5064, Australia)

VEGETATION SCIENCE
35th International Symposium on Applied Vegetation Ecology
21 Sept.-4 Oct., Shanghai, China

(Song Yong-Chang, Inst. of Environmental Science, East China Normal Univ., Zhongshan Bei-lu 3663, Shanghai, 200062, P.R. China)

MEETINGS 1993

BIOPHYSICS

11th International Congress of Biophysics
1-6 Aug., Budapest, Hungary
(J. Tigyi, Institute of Biophysics, Medical Univ., Szigeti ut 12, Pécs, Hungary)

BIOTECHNOLOGY

The Second Arab Conference on Perspectives of Modern Biotechnology
24-28 April, Amman, Jordan
(H. Charif, Organizing Committee, ESCWA, P.O.Box 927115, Amman, Jordan)

BOTANY

15th International Botanical Congress
28 Aug.-3Sept., Tokyo, Japan
(M. Furuya, Frontier Research Programs, The RIKEN Institute, Wako City, 351-01, Japan)

11th General Meeting of the International Association of Botanic Gardens
date undeter., Wuxi, China
(B. Morley, Botanical Garden of Adelaide, North Terrace, Adelaide SA 5000, Australia)

GENETICS

XVIIth Congress of the International Genetics Federation
15-21 Aug., Birmingham, U.K.
(Prof. D.A. Smith, Sec. Gen., XVIIth IGF Congress, Office of Research Support and Industrial Liaison, the University of Birmingham, Edgbaston, Birmingham, B15 2TT, U.K.)

GRASSLANDS

17th International Grasslands Congress
8-23 Feb., Palmerston, New Zealand
(Executive Secretary, XVII Grasslands Congress Organizing Committee, C/-Agronomy Dept., Massey University, Palmerston North, New Zealand)

HISTORY OF SCIENCE

XIXth International Congress of History of Science
22-29 August, Zaragoza, Spain
(Comité Organizador del XIX Congreso Internacional de Historia de la Ciencia, Caja de Ahorros de la Inmaculada (Ag. Urb. 2), P° Fernando el Catolico 42, 50009 Zargoza, Spain)

ICSU

24th General Assembly and Associated Symposia
6-10 Oct., Santiago, Chile
(Executive Director, ICSU, 51 Bld de Montmorency, 75016 Paris, France)

LIMNOLOGY

5th International Conference on the Conservation and Management of Lakes: Strategies for Lake Ecosystems Beyond 2000
17-21 May, Stresa, Italy
(R.M. Società di Congressi s.r.l., Via Ciro Menotti 11, 20129 Milano, Italy)

NUTRITION

15th International Nutrition Congress
26 Sept.-1 Oct., Adelaide, Australia
(R.M. Smith, Sec. Gen., c/o CSIRO, Div. of Human Nutrition, Kintore Ave., Adelaide, South Australia 5000)

PHYSIOLOGY

32nd International Congress of Physiological Sciences
25-30 July, Glascow, UK
(R. Naquet, Lab. de Physiologie Nerveuse, CNRS, 91198 Gif/Yvette, France)

PROTOZOOLOGY

9th World Congress on Protozoology
25 July-1 Aug., Berlin, F.R. Germany
(H. Mehlhorn, Ruhr Univ. Bochum, Postfach 102148, 4630 Bochum, FRG)

SYSTEMATICS

1st International Workshop on Ascomycete Systematics: Problems and Perspectives in the Nineties
11-14 May, Paris, France

(First Ascomycete Systematics Workshop, Univ. Paris 6, Laboratoire de Cryptogamie, Bôite 33, 7 quai St. Bernard, Bât. 50, F-75252 Paris Cedex 05, France)

VIROLOGY
9th International Congress of Virology
8-13 Aug., Osaka, Japan
(D. H. Watson, Univ. of Leeds, Dept. of Microbiology, Leeds LS2 9JT, U.K.)

MEETINGS 1994

AEROBIOLOGY
5th International Conference on Aerobiology
Aug., Bangalore, India
(S. Agashe, Chairman, Organizing Committee, c/o Aerobiology and Allergy Laboratory, Bangalore Univ., Bangalore 560 056, India)

BACTERIOLOGY
7th International Congress of Bacteriology: Applied Microbiology and Mycology
date undeter., Prague Csechoslovakia
(Dr. B. Sikyta, Institute of Microbiology, Czechoslovak Akademy of Sciences, Videnska 270, CS-142 20 Prague 4)

BOTANIC GARDENS
4th International Solanaceae Conference
4-9 Sept., Adelaide, Australia
(D.E. Symon, State Herbarium of South Australia, Botanic Gardens of Adelaide, North Terrace, Adelaide 5000, Australia)

ECOLOGY
6th International Ecological Congress
21-26 Aug., Manchester, UK
(R. Sharitz, INTECOL, Savannah River Ecology Lab., Univ. of Georgia, Aiken, SC 29802, USA)

HERPETOLOGY
IInd World Congress on Herpetology
29 Dec.- 5 Jan., Adelaide, Australia
(Michael J. Tyler, the University of Adelaide, Dept. of Zoology, Box 498 GPO, Adelaide 5001, South Australia)

HORTICULTURAL SCIENCE
24th International Horticultural Congress
21-27 Aug., Kyoto, Japan
(Japanese Society for Horticultural Science, Fac. of Agriculture, Kyoto University, Sakyoku, Kyoto 606, Japan)

IUBS
25th IUBS General Assembly & Associated Symposia
Sept., Paris, France
(T. Younes: Executive Director, IUBS, 51 Bld de Montmorency, 75016, Paris, France)

MICROBIOLOGY
Congress of the International Union of Microbiological Societies (IUMS)
3-8 July, Prague, Czechoslovakia
(B. Sikyata, Institute of Microbiology, Czechoslovak Academy of Science, Videnska 270, Czechoslovakia-14220 Prague 4)

MYCOLOGY
5th International Mycological Congress
14-21 August, Vancouver, Canada
(A. J. F. Griffiths, Botany Dept. University of British Columbia, 6270 University Boulevard, Vancouver, BC V6T 2B1, Canada)

PATHOPHYSIOLOGY
2nd International Congress for Pathophysiology
20-25 Nov., Kyoto, Japan
(T. Sakata, First Department of Internal Medicine, Ooita Medical Univ., 1-1 Idaigaoka Hazamacho, Ooita-gun, Ooita 879-55, Japan)

PHARMACOLOGY
12th International Congress of Pharmacology
Date undeter., Montreal, Canada
(T.Godfraind, Université Catholique de Louvain, Lab. de Pharmacodynamie Générale et de Pharmacologie, Ave. Emmanuel Mounier 73, B-1200, Bruxelles, Belgium)

SOCIAL INSECTS
12th International Congress of Social Insects

29 Aug.-3 Sept., Paris, France
(P. Jaisson, Ethologie et sociobiologie, (CNRS n°667), Université Paris-Nord, 93430 Villetaneuse, France)

MEETINGS 1995

SYSTEMATIC AND EVOLUTIONARY BIOLOGY

Vth International Congress of Systematics and Evolutionary Biology
date ?, Budapest, Hungary
(R. Colwell, University of Maryland, Maryland Biotechnology Institute, Room 1123 - Microbiology Building, College Park MD 20742, U.S.A.)

LIMNOLOGY

26th Congress of the Societas Internationalis Limnologiae
Aug., Sao Paulo, Brazil
(R.G. Wetzel, Dept. of Biology, University of Alabama, Tuscaloosa, Alabama 35487-0344, U.S.A.)

PLANT PROTECTION

XIIIth International Plant Protection Congress
2-7 Jul., The Hague, Netherlands
(J.C. Zadoks, Congress Chairman, Department of Phytopathology, Wageningen Agricultural University, P.O.B. 8025, 6700 EE Wageningen, the Netherlands)

TRAINING COURSES 1992

ICRO/UNESCO

Patch-Clamp in Microorganisms
15-30 Sept., Bogota, Colombia
(W. Stühmer, Max-Planck-Institut für Biophysikalische Chemie, Postfach 2841, 3400 Göttingen, Germany)

Use of Xenopus Laevis Oocytes for Studying Membrane Transport
5-18 Oct., Frankfurt/Main, Germany
(H. Passow, Department of Cell Physiology, Max-Planck-Institute for Biophysics, Heinrich-Hoffmanstr. 7, 6000 Frankfurt/Main 71, Germany)

Molecular Response of Cells to Stress
11-23 Oct., Porto, Portugal
(A. Quintanilha, Centro de Citologia Experimental, R. Campo Alegre 823, 4100 Porto, Portugal)

Fermentation Technology for the Conservation of the Environment
2-13 Nov., Shanghai, China
(Da-Kang Song, Director - MIRCEN China, Institute of Microbiology, Academia Sinica, Beijing 100080, China)

Patch-Clamp Recording Techniques and Intracellular Calcium Monitoring
7-18 Dec., Bogota, Colombia
(Luis Osses, Centro Internacional de Fisica, Bogota, Colombia)

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ARGENTINA- Consejo Nacional de Investigaciones Cientificas y Technicas
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AUSTRIA- Osterreichische Akademie der Wissenschaften
BELGIUM- Royal Academy of Science, Letters & Arts
BRAZIL- Conselho Nacional de Desenvolvimento Cientico e Tecnologico
BULGARIA- Bulgarian Academy of Sciences
CANADA- National Research Council
CHILE- Sociedad de Biologia de Chile
CHINA- Association for Science and Technology, Beijing
CHINA- Academia Sinica, Taipei
CUBA- Academia de Ciencias
CZECHOSLOVAKIA- Czechoslovak Academy of Sciences
DENMARK- Det Kongelige Dansk Videnskabernes Selskab
EGYPT- Academy of Scientific Research and Technology
FINLAND- Delegation of Finnish Academies of Science & Letters
FRANCE- Académie des Sciences
GERMANY - Deutsche Forschungsgemeineschaft
HUNGARY- Academy of Sciences
INDIA- Indian National Science Academy
IRAQ- Scientific Research Council
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JAPAN- Science Council of Japan
JORDAN-Yarmuk University, Irbid, Jordan
MEXICO-Consejo Nacional de Ciencia y Tecnologia
MONACO- Centre Scientifique de Monaco
NETHERLANDS- Koninklijke Nederlandse Akademie van Wetenschappen
NEW ZEALAND- Royal Society of New Zealand
NORWAY- Det Norske Videnskaps Academi
PHILIPPINES- Natioanl Science Society
POLAND- Academy of Sciences
ROMANIA-Academy of Sciences
RUSSIA- Russian Academy of Sciences
SAUDI ARABIA- King Abdulaziz City for Science & Technology
SOUTH AFRICA- Foundation for Research Development
SPAIN- Comision Interministerial de Ciencia y Tecnologia
SWEDEN- Kunglige Vetenskapsakademien
SWITZERLAND- Swiss Academy of Sciences
UNITED KINGDOM- Royal Society
U.S.A.- National Academy of Sciences- National Research Council
VENEZUELA- Consejo Nacional de Investigaciones Cientificas y Tecnologicas
YUGOSLAVIA- Union of Biological Sciences