# BIOLOGY INTERNATIONAL

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

1994 July

N° 29

## CONTENTS (N° 29, 1993)



ISSN 02532069

# Editorial

## Matching Rigor with Openness in Biology

Most biologists, and in particular those dealing with complex systems, are facing an existential dilemma at present. Sometimes the results of their research are not very well known even by their own colleague scientists, not to mention by the media and public-at-large. The societal impact and relevance of their results appear to be negligible or at least largely ignored, and it is rare that these results are at all applicable in the outside world.

As a result, the niche of public visibility in these fields (ecology, biodiversity, hydrobiology, environmental biology, etc.) is taken over - much too often - by "instant scientists", with unknown university backgrounds, almost devoid of research experience, with no associated students, and not belonging to the so-called scientific community. These individuals however, tend to answer to the whims and demands of the media, that is to say, sensationalism, catastrophicism, or a romantic attachment to a wilderness past. Admittedly, they are very "palatable" from this standpoint.

Consequently, research is losing ground, particularly in the governmental and inter-governmental circles. Statements such as "no more research is needed" or "the time has come now just for applications" are made repeatedly. The entire Rio process has been impregnated *de facto* with this vision. The most illuminating case is that of research being virtually vetoed (i.e., the word "research" should simply be censured in order to get a project approved) in managing the huge amount of money of the Global Environmental Facility (GEF). This has happened in spite of the fact that biodiversity is certainly the "greatest scientific unknown" of the generations to come, in terms of taxonomy, ecology, population genetics, molecular and population biology, ecosystem functioning, resource management, etc.

Admittedly, many biologists have widened their approach to involve, or even to lead, interdisciplinary endeavours, and to adopt a new kind of attitude *vis-à-vis* communicators, entrepreneurs, and decision-makers. A few of them have been successful, thus demonstrating the practicality of this openness and of these new partnerships.

Nevertheless, this is not an easy path to follow. Much of the interdisciplinary research lacks rigorous working hypotheses and stringent problem-solving orientations. Interdisciplinarity is not synonymous with undisciplined work, nor is it the negation of scientific disciplines. When this occurs, research results remain then unpublishable or unpublished, or only appear in the grey literature.

Furthermore, research results are too often presented by the media in an amazingly biased fashion, with or without the authorisation of the authors; disenchantment and reluctance to collaborate are understandable reactions on the part of the scientists concerned. It is also true that a few good scientists are moving almost ineluctably towards ideological and dogmatic tendencies in order to acquire higher visibility. Preaching and teaching are not synonymous.

It is not intended here that scientists blame everyone else (media, decision-makers, the business community, the public flavour, etc.) for this state of affairs. Individual scientists are often prisoners of a career system that does not adequately reward or encourage relevance and impact of research. High quality, but routine and easily publishable papers are invading most of the scientific journals, and are the bulk of many academic careers. Some bodies representing the scientific community are rivalling with their governmental counterparts by adopting rigid procedures, in which formalism is sublimated to the detriment of content and originality.

I would only like to contend that scientific rigor is not antagonistic to openness towards other problems and other audiences; that interdisciplinarity is compatible with a very rigorous research hypothesis, insofar as the team keeps its size at a minimum as related to its precise target; that partnerships with intergovernmental bodies, politicians, decision-makers, entrepreneurs, communicators are possible and desirable when handled in a fair and equitable way, thus avoiding capture by the intrinsic logic of others. Constant self-criticism is a must.

Of course, partnership is also now becoming a magic and mythical word. But we have to safeguard the rationale behind this word as well as the actions involved if we wish to have any influence whatsoever during this period of economic crisis and societal instability.

*Memento audere semper* (remember to always dare). In other words, remember that it is always worth taking risks to achieve a given goal, but there will be no relevance or impact of research results without the backing of scientific rigor and integrity.

*Francesco di Castri*
*President, IUBS*

# DIVERSITAS:
## Yesterday, today and a path towards the future

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## 1-Introduction

Almost three years have passed since the IUBS adopted the *Diversitas* programme at its 24th General Assembly, held on 1-6 September 1991, in Amsterdam. Undertaken in collaboration with UNESCO and SCOPE, this programme should be *per se* a factor of unity and the centre of interaction for the overall IUBS activities. It reflects, indeed, what the Union represents at the international level, that is to say, a unique organisation where all the scientific disciplines dealing with the diversity of life forms and the hierarchical levels of integration are represented, including animals, plants, microorganisms, cells, species, communities, ecosystems and landscapes, and the multiplicity and complexity of biological processes and functions.

In less than two months, *Diversitas* will be the main focus of two important international meetings. The International Forum "Biodiversity, Science and Development. Towards a new partnership", which will take place on 5-9 September 1994, at the UNESCO headquarters in Paris, draws its scientific background from *Diversitas*. The second, organised in conjunction with this Forum, is the IUBS 25th General Assembly and has the task of reviewing the three-year period of the *Diversitas* operation, and subsequently, of making the appropriate decisions regarding its future development.

In order to assist the participants at both the Forum and the Assembly in their deliberations, this article aims to provide a historical background, the major objectives and the conceptual framework of *Diversitas*, as well as an overview of the major developments that occurred since its adoption three years ago.

## 2- Historical Background

The IUBS concern for biological diversity was prominent within the Decade of the Tropics programme (1983-93). The study of species diversity and its significance in tropical ecosystems (Maury *et al,* 1984; Lugo, 1988) was one of the major themes of this programme, while aspects related to genetic variability and diversity of tropical human populations (Roberts and di Stefano, 1986) were also addressed by the other projects of the Decade.

A proposal made by the US National Committee of IUBS (Simpson, 1988), led to the decision made by the IUBS Canberra General Assembly in 1988 to undertake a feasibility study for launching a major programme on biological diversity. Complying with this

resolution, a series of activities were launched in order to identify the key scientific questions and hypotheses, and to develop the scientific framework of the programme. The most significant results of these activities consist of three IUBS documents, namely *Ecosystem Function of Biological Diversity*, edited by F. di Castri and T. Younès, 1990 ; *Marine Biodiversity and Ecosystem Function* edited by Grassle *et al.*, 1991; and *From Genes to Ecosystems: A Research Agenda for Biodiversity* edited by O. Solbrig, 1991.

In addition, the symposium *Biological Diversity and Global Change*, held concurrently with the 24th IUBS General Assembly in Amsterdam in 1991, provided an excellent opportunity to discuss the relevance and role of biodiversity within the broader context of global change. This symposium received a positive public response as stated in *The Economist* (1991), and the proceedings (edited by Solbrig *et al*, 1992), have been widely used for university teaching.

This IUBS Assembly (1991) adopted the scientific programme entitled "Ecosystem Function of Biodiversity". However, the topic of biological diversity can be looked at from many perspectives, and it was noted that most of the international organisations were developing their own programmes. In order to avoid duplication and overlap, and to increase interaction, appropriate arrangements were made between IUBS, SCOPE and UNESCO, all international organisations sharing complementary views and interests, to jointly co-sponsor the programme, thus named *Diversitas*.

The ICSU Scientific Committee on the Problems of the Environment (SCOPE), which shares with IUBS the particular concern of preparing a review on ecosystem function of biodiversity, formally agreed to co-sponsor *Diversitas* at its General Assembly, held in January 1992, in Seville (Spain). UNESCO, through its Man and Biosphere (MAB) Programme, had already expressed the intention to join *Diversitas*, a decision which was formally adopted by the UNESCO General Conference in October 1991.

Close collaboration has also been developed with other members of the ICSU family, namely the International Union of Microbiological Societies (IUMS) with special reference to microorganisms diversity, and with the International Geosphere-Biosphere Programme (IGBP) with reference to the Global Change and Terrestrial Ecosystem (GCTE) focus 4 on "Ecological Complexity".

## 3-*Diversitas*

### 3.1. Objectives

*Diversitas*, by its very definition, covers the diversity of all living beings on the planet. One major objective of *Diversitas* is to identify relevant scientific questions and to promote collaborative research that requires international cooperation.

In addition, *Diversitas* acquired an additional sense of urgency following the adoption of the Convention on Biological Diversity by the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in June 1992. This Convention, which contains provisions intended to curb the destruction of living species,

habitats and ecosystems, draws attention to the *general lack of information and knowledge* regarding biodiversity.

Indeed, myths and realities are inextricably combined and there is a clear scientific responsibility for unravelling myths on biodiversity. Some of the current myths are illustrated in Fig. 1.

Furthermore, the Convention underlines the urgent need to develop scientific, technical and institutional capacities to provide basic understanding upon which to plan and implement appropriate measures. Several points require urgent attention by the scientific community, including the need to:

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

### 3.2. The Conceptual Framework

The conceptual and operational framework of the *Diversitas* programme (Fig. 2) has been designed to deal with the main scientific issues that are necessary to address for a better understanding of the structure, functioning and change of biodiversity, as well as the scientific aspects underlying its conservation and management.

*Diversitas* addresses a series of scientific themes, that were first established at the IUBS-SCOPE meeting on "Ecosystem Function of Biodiversity", in 1989, at the US National Academy of Science (NAS), in Washington, D.C. They are as follows:

(1) Ecosystem Function of Biodiversity;
(2) Origins, Maintenance and Loss of Biodiversity;
(3) Biodiversity Inventorying and Monitoring;
(4) Conservation of Wild Relatives of Cultivated Plants and Domesticated Animals.

Also, *Diversitas* covers three aspects that have been somewhat neglected up until present: **marine biodiversity, microorganisms diversity**, and the **human dimension of biodiversity**, particularly the impact of human societies on biodiversity change.

Furthermore, the *Diversitas* programme is founded on an approach taking into account: a) the complex, dynamic and hierarchical nature of biodiversity; b) a network based on representative sites for inventorying and monitoring biodiversity both in space and over time; and c) the development of very important and urgently needed taxonomic bases, including taxonomic research, training and education related to conservation and management of biodiversity.

Some of the added values of paramount importance inherent to a scientific programme such as *Diversitas* are highlighted in Fig. 3.

Figure 1:

# DEBUNKING *MYTHS* ABOUT BIODIVERSITY

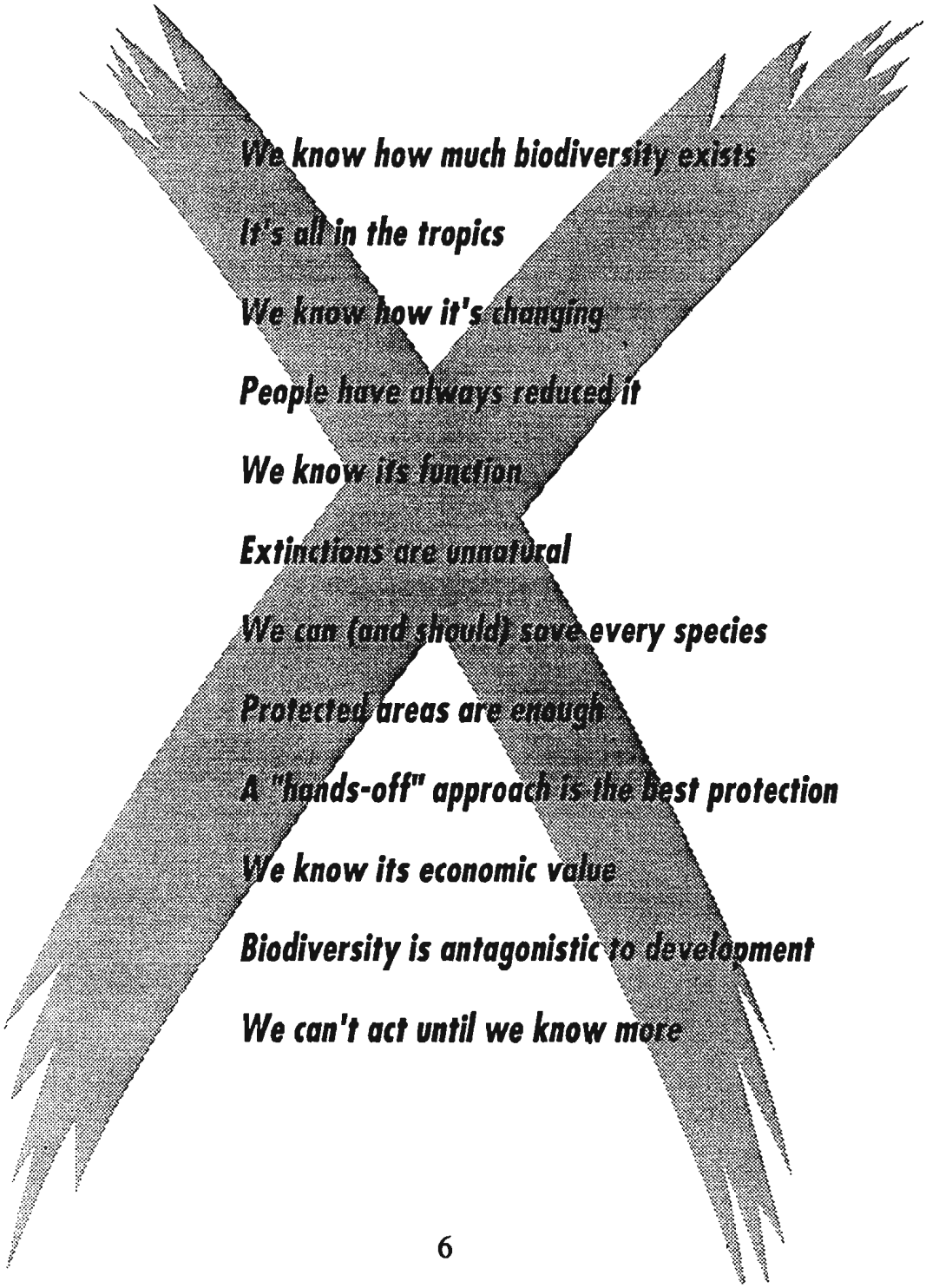
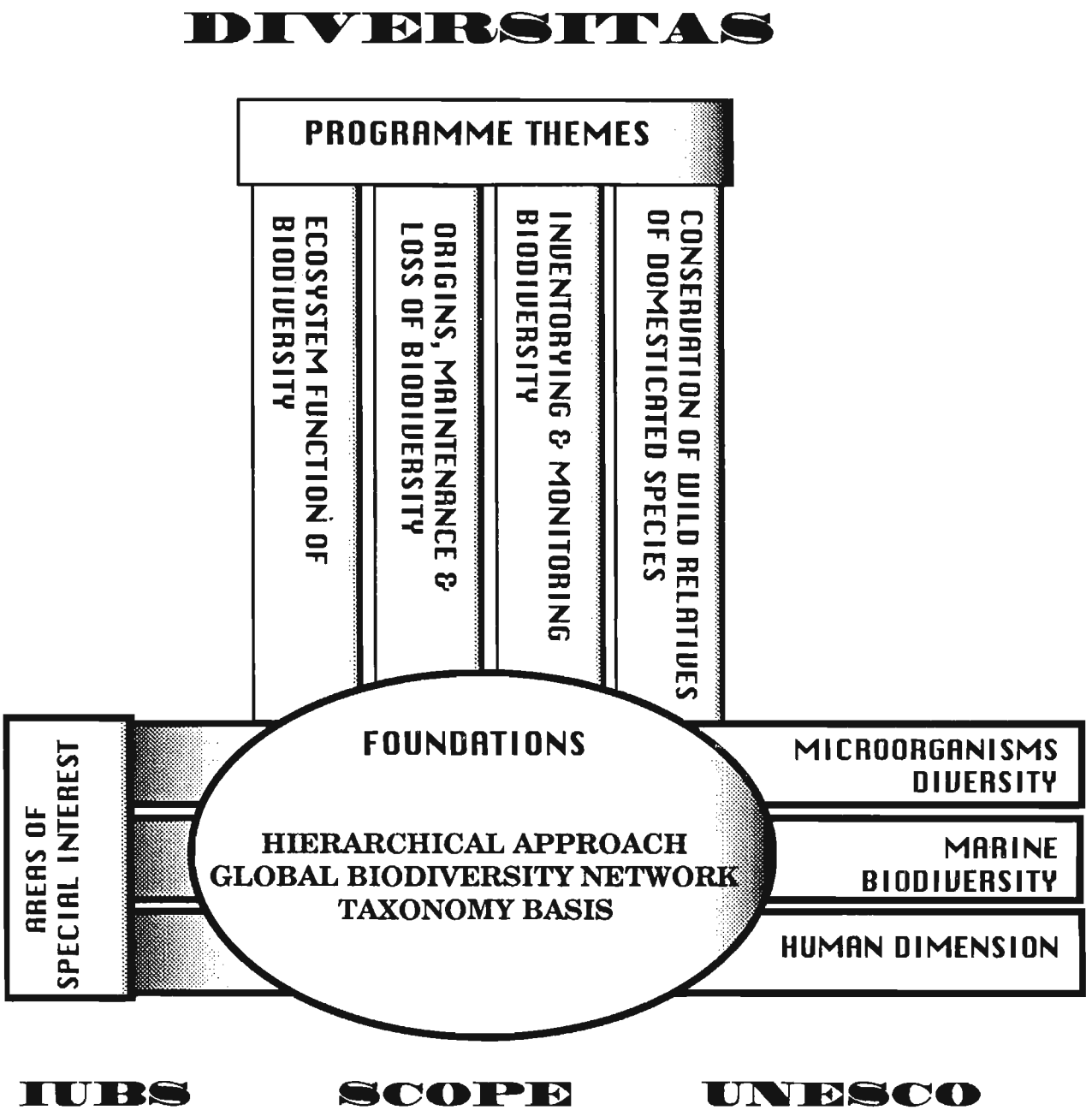
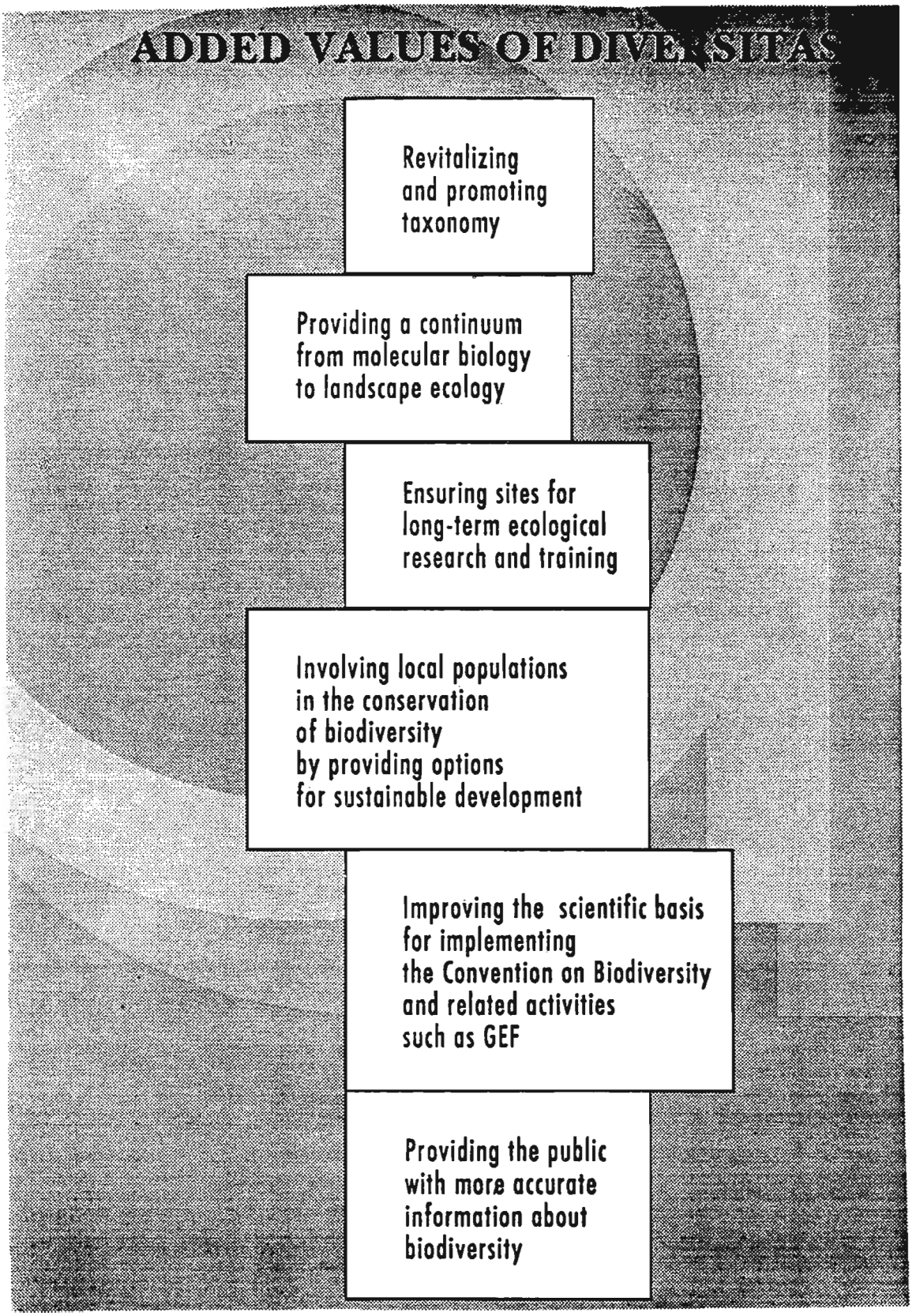


Figure 2 - Conceptual framework of the *Diversitas* Programme




ADDED VALUES OF DIVERSITAS
Revitalizing and promoting taxonomy
Providing a continuum from molecular biology to landscape ecology
Ensuring sites for long-term ecological research and training
Involving local populations in the conservation of biodiversity by providing options for sustainable development
Improving the scientific basis for implementing the Convention on Biodiversity and related activities such as GEF
Providing the public with more accurate information about biodiversity

### 3.3. Organisation

In compliance with the resolutions of the IUBS 24th General Assembly (1991), an overall *Coordinating Committee* of the programme was established involving all co-sponsoring organisations. Its major task is to coordinate the various projects and activities of the programme.

Considering the fact that *Diversitas* is a long-term research programme and that there is a need to provide policy makers with interim results as soon as they are requested, the Coordinating Committee also has the responsibility of identifying potential topics for assessment and analysis. The products of such assessments should be technical reports, as well as shorter non-technical briefs for policy makers.

At present, this Committee is composed as follows: Francesco di Castri (Italy), Chairman; Madhav Gadgil (India), David L. Hawksworth (UK), Harold Mooney (USA), Robert Barbault (France), Valeri Neronov (USSR), Pierre Lasserre (UNESCO), Eduardo Fuentes (Chile), Talal Younès (IUBS) and Veronique Plocq (SCOPE), Members. These members are entrusted to make relevant *ad hoc* recommendations to the overall Committee concerning projects and activities closest to their area of expertise.

Since its establishment, the Committee has met each year: 4 October 1991, in Bayreuth (Germany), 23-24 April 1992 and 24-25 June 1993 at the IUBS Secretariat in Paris. The Coordinating Committee proceeded with annual reviews of the four *Diversitas* themes, considering for each one, the establishment of a scientific advisory committee, action plans and implementation strategies, and outputs. Also, the Committee established special interest transversal groups to deal with aspects related to biodiversity in marine ecosystems, the diversity of microorganisms, and the human dimension of biodiversity.

In order to ensure effective communication with the general public, an information leaflet on *Diversitas* (UNESCO, 1992) was produced on the occasion of the Rio Conference. Later, within the 'Environmental Briefs Series' of UNESCO, a brochure devoted to biodiversity (di Castri *et al.*, 1994) was published in English, French and Spanish. Also, two progress reports were published in *Biology International* issues in 1992 and 1993. Furthermore, a number of news items were published by the media.

Following UNCED, and in order to assist with the preparation for the Conference of the Parties of the Convention on Biological Diversity, the United Nations Environment Programme (UNEP) developed a project entitled Global Biodiversity Assessment (GBA) with the support of the Global Environmental Facility (GEF). Since the GBA project was designed along the lines of *Diversitas,* it was agreed, whenever and as much as possible, to join efforts for the development of common scientific themes.

## 4- *Diversitas* Central Themes

### 4.1. Biodiversity and Ecosystem Function

Aiming to synthesise our knowledge of the functional role of biodiversity and to help design an experimental programme, this theme addresses two basic questions:

- How is system stability and resistance affected by species diversity and how will global change affect these relationships ?

- What is the role of biodiversity (species and landscapes) in ecosystem processes (e.g. nutrient retention, decomposition, production, etc.) including feedbacks, over short- and long-term spans, and in face of global change (climate change, land use change, and invasions) ?

The sequence of activities that took place in the period 1991-1994 includes a workshop on background issues held in 1991, followed by a series of twelve regional workshops and two special foci meetings, and ending with a final synthesis symposium, held in 1994.

The initial meeting on ***background issues*** took place in October 1991, in Bayreuth. It brought together ecologists and population biologists, who were both interested in evaluating the consequences of human-driven disruptions of natural systems. In particular, there was an examination of the degree of redundancy within systems, the ubiquity of keystone species, the tightness of species interactions (from mutualisms to food webs), the resilience of systems to perturbations, and the interaction of landscape units. The few direct studies on species numbers and ecosystem function were evaluated. The interaction of policy and science in this area was also explored. The resulting book, *Biodiversity and Ecosystem Function*, edited by Schulze & Mooney, was published in 1993.

Following this meeting, a series of meetings focusing on ***specific biotic regions*** of the world, was organised during 1992-1993. Twelve biotic regions were selected to represent particularly critical areas in terms of threats to diversity losses, or particularly sensitive to global change effects, or especially amenable to experimentation. These regions are as follows: estuaries, lagoons, and mangroves; mediterranean systems; islands; boreal forest; tundra; coral reefs; tropical savanna; upwelling systems; tropical forests; lakes and rivers; temperate forests, and arid zones.

The regional meetings aimed to comprehend the nature of the biodiversity of these biotic regions, as well as to understand how a particular system is being modified, and to learn of potentially differential structural/functional relationships among systems. To get a uniform treatment of the various biotic regions, the same questions and issues have been addressed for each one:

- Natural diversity of systems: species, populations, functional groups, systems and landscapes;
- Impact of change on diversity: climate and atmosphere, land use, and invasions;
- Assessing the role of diversity on ecosystem function: additions (invasion analogue), subtractions (harvesting, disease, etc.), fragmentation, and disturbance;
- Reconstructing and maintaining diverse systems;
- Refining our knowledge through explicit experiments and long-term observations.

Also, two **special foci** meetings were organised in 1993, one on "*Ecosystem Functional Units*" and another on "*Ecosystem Reconstruction*".

The ***final synthesis*** meeting was held on 27 February-2 March 1994, in Asilomar, California, and organised by SCOPE. Participants included the leaders from all of the activities described above, along with those scientists having made substantial contributions during the regional meetings. In addition to the final synthesis of the programme, which will be published in the SCOPE series by Wiley, the meeting identified the research priorities and recommendations to be delivered to IGBP. Also, it made a substantive contribution to the Global Biodiversity Assessment (GBA) coordinated by UNEP.

The ***Scientific Advisory Committee*** for the Biodiversity Ecosystem Function theme consists of: H. Mooney (USA), Chairman; E. Medina (Venezuela), E.-D. Schulze (Germany), D.L. Hawksworth (UK), O.T. Solbrig (USA), V. Neronov (USSR), B. Huntley (South Africa), and P. Lasserre (France), Members.

## 4.2. Origins, Maintenance and Loss of Biodiversity

The conceptual framework outlined in the proceedings of the Harvard Forest Workshop "From genes to ecosystems: a research agenda for biodiversity" (Solbrig, 1991), represents the basis for the development of the second *Diversitas* theme "Origins, Maintenance and Loss of Biodiversity". Emphasis is placed on the study of biodiversity at infraspecific genetic and population levels, as well as on the processes and mechanisms of speciation and species extinction, which represents an important step for understanding diversity at higher levels. Indeed, how a species reacts to changes in its environment depends on a number of elements such as genetic, physiological, species interactions and life history factors.

Special emphasis will be put on the modelling approach to understand how species or genetic variability can affect the dynamics of species and population extinction, and perhaps to provide predictive models for biodiversity at time scales of years to decades. Also, it is very important to make a clear distinction between local and global extinctions, and their corresponding management implications.

As a follow-up to the Harvard Forest workshop, and in collaboration with UNEP's project, Global Biodiversity Assessment (GBA), a workshop was convened by R. Barbault, chairman of this *Diversitas* theme. Held on 7-11 November 1993 in Paris, the meeting's goal was to refine the hypotheses related to the origins, maintenance and extinction of biodiversity.

The main topics addressed were:

1- The origins of biodiversity
2- The palaeorecords: the history of present biodiversity
3- The dynamics of biodiversity at the population level
4- The ecology and genetics of extinctions:
   - Problems of measuring current and predicting future extinction rates
   - Genetic erosion, its measurement and consequences
   - Systems for determining threats to species and other taxa
   - Minimal Viable Populations and Population Viability Analysis
   - Metapopulations dynamics

5- The dynamics of biodiversity at the ecosystem level
6- The role of humans in shaping biodiversity:
   - The effects of human management practices and harvesting techniques in the long- term perspective
   - Multiple time dimensions, including origins of agro-biodiversity
   - Introduced species

Issues that will be addressed either in specific workshops or within more general ones, are the following:

- the role and effects of parasite/host and mutualistic relationships on biodiversity changes;
- linking biodiversity issues, particularly at the level of genetic variability and population dynamics, with global change concerns (green house effects as well as land use changes);
- population viability analysis, and genetics and dynamics of metapopulations or fragmented populations in a changing environment;
- the ecology and genetics of rarity: patterns, causes and consequences.

The task that the working group of this theme is facing is both very challenging, given the importance of the issues, and difficult due to the scarcity of available knowledge in this area.

The **Scientific Advisory Committee** of the *Diversitas* theme on "Origins, Maintenance and Loss of Biodiversity" is composed of R. Barbault (France) Chairman; E. Alvarez-Buylla (Mexico), P.H. Gouyon (France), I. Hanski (Finland), H. Kawanabe (Japan), B. Schaal (USA), S. Stearns (Switzerland), M. Slatkin (USA) and G. Vida (Hungary), Members.

### 4.3. Inventorying and Monitoring of Biodiversity

Quite different from the two preceding themes, the "Inventorying and Monitoring" theme has proved to be more complex and difficult to develop. This could be easily explained by the need for more funding, closer interaction with the countries involved, and a long-term commitment of national authorities and research institutions.

In spite of the above-mentioned constraints, the work undertaken since the launching of this *Diversitas* theme has helped clarify some of the main issues initially identified, such as defining the key biomes and groups as well as the most appropriate methods and scales for inventorying and monitoring biodiversity. Also, the establishment of a network for inventorying and monitoring global biodiversity has been advocated.

The point of entry for biodiversity inventorying and monitoring lies at species and landscape levels. The Harvard Forest workshop had already identified the need to deal with inventorying methods for various taxa, the techniques for assessing species richness, and the organisation of a biodiversity network. It also suggested that monitoring should not be confined to biological variables, but should include physical variables such as soils and climate as well.

In order to clarify these issues, a workshop was organised on 30-31 January 1992 at the UNESCO headquarters in Paris. As a result, the report "Inventorying and Monitoring Biodiversity: a proposal for an international network" edited by di Castri, Robertson-Vernhes and Younès, appeared in *Biology International* Special Issue n° 27, and was also published in *Vegetatio* (1992). This document explored the issues of scale and network of biodiversity inventorying and monitoring, as well as the appropriate study approaches, taking into consideration the constraints and limitations of available financial and human resources.

Regarding the question of the **space scale,** thought must be given to the geographical comparative approach, since single-site studies reveal very little and can even be misleading. A holistic view of the status of biodiversity on the global level can only be achieved by selecting a series of comparable sites and using similar sampling methodologies. Applying this approach for inventorying can be viewed as a world-wide experiment relying on replicates for comparative analyses over space.

As far as a **time scale** is concerned, there is a need to reinstate the role of history and the role of change with time in a scientific study of biodiversity. It is the long-term studies which give the most meaningful results as they point out the gradual trends over time, as opposed to the uneven fluctuations occurring over short time periods. The monitoring work prescribed in this document can be seen as a first attempt to discern the changes over time in the composition and in the functional aspects of biodiversity. Use is to be made as much as possible of sites possessing long data records, in order to study biodiversity retrospectively and to give more perspective to current data.

In addition, a **network** approach has been advocated to provide a conceptual framework for inventorying and monitoring biodiversity. The rationale is to enable the analysis of comparable sites (within the same ecosystem type, for example) in terms of species composition and function, and their evolution over time. Such a framework can be constructed from a minimum number of sites forming a pilot network. Studies in other sites, both past and ongoing, can be "added", thus giving a new vantage point from which to view old data and assess them in a relative context for better understanding biodiversity.

Furthermore, the notion of **intensive and extensive studies** was recommended, whereby a larger number of sites would undertake a minimum amount of inventorying and monitoring using selected taxa or guilds, and only a restricted few would undertake intensive, comprehensive studies. The proposed network for inventorying and monitoring biodiversity should include the following terrestrial biomes: tropical rain forests, tropical savannas, temperate rain forests, temperate deciduous forests, temperate grasslands, and tundra, as well as a series of marine sites.

As a follow-up to this meeting, a second workshop on inventorying and monitoring diversity was organised at La Selva Biological Station (Costa Rica) on 1-3 October 1992 (Robertson Vernhes & Younès, 1993) with research scientists from 25 terrestrial sites, as well as directors of marine stations or laboratories for the marine component. This meeting made it possible to refine the scientific questions to be addressed by a global system for inventorying and monitoring biodiversity, particularly the notion of extensive and intensive study sites, and to establish a preliminary list of potential sites, identifying other important habitats such as tropical mountains and arid zones.

As an example of international cooperation related to *Diversitas*, the preliminary work on this theme (the Harvard Forest workshop, 1991, the reports of the meetings at UNESCO, January 1992 and at La Selva, Costa Rica, in October 1992), helped stimulate the idea of setting up an "All Taxa Biological Inventories" (ATBI), which consists of an intensive taxonomic survey at a given site, complemented as appropriate by some 30 to 40 satellite plots set up for specific purposes. Countries having shown an interest include Costa Rica, United States, Brazil, China and Norway.

A third meeting of the Scientific Advisory Committee on Inventorying and Monitoring was held on 30-31 March, 1993, at the IUBS Secretariat in Paris, and proposed that three or four position statement documents be prepared in order to elucidate some outstanding questions for inventorying and monitoring biodiversity. These documents would be prepared and circulated to some 40-50 specialists for comment. They are as follows:

(a) Taxonomy: This would look at available taxonomic resources world-wide and the distribution of biodiversity from a taxonomic point of view (e.g., reviews of herbaria and museum collections, keys for specific taxa or groups of taxa), thus highlighting major gaps. Indicator groups for inventorying and monitoring would be selected based on widely acceptable criteria.

(b) Sampling, Ecological Concepts and Monitoring: This would look at problems of sampling a wide range of organisms including problems of temporal and spatial scales. Problems of experimental design, statistics and ecological principles of inventorying and monitoring need to be discussed.

(c) Networking: Issues to be discussed include data standards, compatibility, electronic data and images of specimens.

Given this background, the Coordinating Committee decided that the theme of inventorying and monitoring biodiversity under *Diversitas* would have to be reformulated, focusing on the following elements:

a- the global biodiversity inventorying and monitoring network should be built up in an opportunistic manner, capitalising on interests of countries and individual scientists. In other words, the network should be country driven;

b- *Diversitas* should facilitate and catalyse the actual work on inventorying and monitoring in the different countries, by becoming an "enabling mechanism". This means ensuring a global network function by providing a means for comparable studies (for example by providing standard manuals) and exchange of information through publications, meetings and synthesis of results;

c- *Diversitas* should lend importance to the taxonomic aspects, preparing sampling manuals for some 100 selected 'indicator' taxa to be monitored at the genetic, population and ecosystem levels. *Diversitas* should also help the countries to build up their capacity to undertake this work, thus giving rise to a 'global biosystematic network', also to be coordinated by *Diversitas*.

d- *Diversitas* should also act as a broker to help seek the required funding for national initiatives which would contribute to the overall global effort of inventorying and monitoring biodiversity.

The original Steering Committee for Inventorying and Monitoring Biodiversity is as follows: Francesco di Castri (Chairman-*Diversitas*); Nigel Stork- Coordinator-Inventorying (UK), Jerry Franklin-Coordinator-Monitoring (USA), Zhao Shidong (China), Gonzalo Halffter (Mexico), Kenneth Campbell (Tanzania), T. Khoshoo (India), and Talal Younès. However, it is advisable that a new Steering Committee be proposed in order to reflect new developments at both national and international levels.

### 4.4. Conservation of Wild Relatives of Cultivated Plants and Domesticated Animals

The need to deal with the issue of "Conservation of Wild Relatives of Cultivated Plants and Domesticated Animals" was proposed at the workshop "Ecosystem Function of Biodiversity", held in 1989 in Washington, D.C. However, a proposal to develop this theme was only recently made and approved at the *Diversitas* Coordinating Committee meeting held in June 1993. Prof. V. Heywood (Reading University, UK) was appointed Chairman, and the initial meeting to develop this theme took place in May 1994, in Rome. This was held in cooperation with the International Plant Genetic Resources Institute (IPGRI) and the IUBS/ISHS Medicinal and Aromatic Plants programme. The final report of this meeting is in preparation and will be made available at the next General Assembly of IUBS.

### 4.5. Microorganisms Diversity

Microorganisms exhibit the greatest breadth of genetic diversity on Earth. Less than 5% of the world's microorganisms have been described as yet, and it is not improbable that their real number exceeds even that of insects.

Innumerable microorganisms, such as algae, bacteria (including *cyanobacteria* and myco-plasmas), fungi (and also lichens and yeasts), protozoa, viroids and viruses, are essential to the survival of all organisms as basic components of food chains, and perform crucial and unique roles in the planet's biogeochemical cycles. They are vital to the function and maintenance of ecosystems and the biosphere. As major contributors in biogeochemical cycles, they perform unique and indispensable activities in the overall circulation of matter on which all larger organisms, including humans, depend.

Microorganisms constitute a genetic resource of great potential for contributing to the sustainable development of the planet, as well as to human, animal and plant health. Urgent attention to redress our ignorance on many key aspects of their scientific understanding, such as their distribution and functions, is required.

In collaboration with the International Union of Microbiological Societies (IUMS), a distinct component of *Diversitas* was established contributing to the other themes of the programme. A series of activities were undertaken including:

- a joint IUBS-IUMS meeting on *Biodiversity Amongst Microorganisms and its Relevance* was held in September 1991, in Amsterdam, and the proceedings published in *Biodiversity Conservation* (1992) 1 (4):219-345;

- an *ad hoc* working-group on microorganisms diversity met in Barcelona (Spain) in September 1992, followed by a workshop organised within the framework of the 7th International Congress on Culture Collections, held in Beijing (China) on 12-16 October 1992 (*Cf. Biology International* 26:24-25).

-a workshop on the *Needs and Specifications for a Biodiversity Information Network* held at the Tropical Data Base, Campinas (Brazil), 26-31 July 1992, was attended by 35 people from a number of international organisations. It was made available on-line through a variety of electronic networks and was accessed by some 200 people, 30 of whom sent contributions to the discussions;

- an IUBS/IUMS workshop on *Microorganisms and the Maintenance of Biodiversity*, co- sponsored by the European Community, was organised on 10-13 August 1993 at the University of London, Egham, and the proceedings will be published by the Commonwealth Agricultural Bureau (CAB) International.

### 4. 6. Marine Biodiversity

Many considerations led to the establishment of a distinct transversal component on Marine Biodiversity within *Diversitas*. Most of the concepts related to biodiversity have been derived from studies of terrestrial systems where, on a global scale, there is a clear pattern of increasing diversity from the poles to the tropics. In the marine realm this is *not the case*, and certain groups of organisms may reach maximum diversity in polar regions (*e.g.* mammals), temperate regions (*e.g.* seaweeds) or the tropics (*e.g.* corals, mangroves).

For most animal phyla, the pattern is simply not known because strictly comparative data are lacking. In fact, for the marine environment, biodiversity is only now beginning to be documented and the implications of its differing facets being appreciated. Also, we are far from understanding the importance of biodiversity in the functioning of marine ecosystems and their processes. An indepth consideration of this problem is necessary since it has important implications for the management of marine ecosystems and the way in which they are eventually exploited. Furthermore, the scales of the processes determining the distributions of many marine species are considerably larger than those on land. Conservation of marine ecosystems and processes thus has very different facets than the conservation of individual marine species.

The recent discovery of very small plankton (picoplankton) has major implications for the primary production and turnover in oceans. These widespread unicellular pico-eukaryotes, cyanobacteria, and pro-chlorophytes appear to play a significant role as a sink for atmospheric carbon dioxide.

Except for certain marine areas where habitat alteration is extensive (coastal wetlands, mangroves and lagoons, for example), species extinction in marine environments does not appear to be as great a problem as in land areas due to the greater range of distribution and the fecundity of most marine species.

During the period 1992-1994, the activities undertaken by the Diversitas Marine Biodiversity Group include a workshop "Ecosystem Function of Biodiversity in Lagoons,

Mangroves and Estuarine Systems" held in March 1993, in Guadeloupe, and a series of meetings organised with the aim to establish a *Marine Laboratory Networks for the Study of the Biodiversity, Function and Management of Marine Ecosystems* (Lasserre *et al*, in press).

A proposal for an international framework for cooperative sites in the marine realm is based on the already existing networks: the European Marine Research Stations (MARS), the US National Association of Marine Laboratories (NAML), and the regional networks in the UNESCO-COMAR (Coastal Marine Research) comparative ecology projects, and MAB Biosphere Reserves. Focusing on the distinctive features of biodiversity of marine systems in comparison with terrestrial ones, this network represents a major contribution to *Diversitas*, in addressing the research priorities in marine systems dealing with biodiversity origins and maintenance, and its role in ecosystem function and sustainability.

### 4.7. Human Dimension of Biodiversity

Human studies are of immediate relevance to each one of the *Diversitas* themes. The initial planning meetings for *Diversitas*, while not excluding the contributions that human biology can make, gave them little attention. Everybody seemed to accept that the human role was restricted to that of the destroyer of biodiversity.

The 24th General Assembly of IUBS in Amsterdam noted that "...attention should be also paid to the need to recognise that humans are an integral part of ecosystems, and to include this dimension when appropriate", and then proposed the organisation of a workshop on this subject.

Conforming with this resolution, a workshop entitled "Man, Culture, and Biodiversity-Understanding Interdependencies" was organised in April 1994, in Denver. The main questions addressed were as follows: (1) to enquire into the duration of human influence on the biological environment, seeking evidence from those early periods when human populations were not large enough or developed enough to do permanent harm on coexisting species and their environment; (2) how recent and contemporary cultures with their close relationship to their environment helped to maintain biodiversity; (3) what is the role of humans in modifying biodiversity in present times; and (4) what is the effect of changing biodiversity on humans. The report of this workshop will be published as a Special Issue of *Biology International*.

## 5. Cooperation with National Members and International Organisations

With regard to the implementation of *Diversitas*, a mixed strategy was adopted, combining a very selective approach with a well defined number of themes and participants, together with a much larger approach allowing for a wider commitment and participation of both national and scientific members of IUBS. This approach has resulted in the initiation and development of a number of national and regional *Diversitas* initiatives, as well as in establishing arrangements with international organisations. The most notable examples are as follows:

## 5.1. National and Regional Developments

### *European Activities*

Convened by the European Commission (EC) and *Diversitas*, a European meeting on "Ecosystem Function of Biodiversity" was held on 11-13 July 1993, at the University of London, Wye. The objectives of this meeting were to promote biodiversity research in Europe following the *Diversitas* conceptual framework, and to provide the EC with priority themes and research topics for inclusion in its 4th Research Plan.

In *France*, the IUBS National Committee developed a national *Diversitas* programme with the contribution of French scientific institutions including: CNRS, IFREMER, INRA, ORSTOM, the Ministry of Higher Education and Research and other institutions.

Similarly, in *UK*, the IUBS focal group in cooperation with a number of British scientific institutions are making plans for the development of a UK programme on biodiversity modelled after *Diversitas*.

### *USA and Costa Rica*

A Conference on Biodiversity Assessment was convened by Prof. T. Lovejoy on behalf of the US Government, in Washington, D.C., 13-16 January 1993.

In addition, following the *Diversitas* meeting on Inventorying and Monitoring, held at La Selva (Costa Rica), a workshop was organised on "All Taxa Biodiversity Inventory" (ATBI) in Philadelphia, in April 1993. Following this meeting, a proposal for including ATBI Sites in the *Diversitas* programme was submitted by Profs. R. Gamez, D. Janzen and W. Hallwachs.

### *Japan and West Pacific Asian Countries.*

A national initiative, entitled SymBiosphere, has been launched in *Japan* as a contribution to *Diversitas*. Also, a regional network of *Diversitas Western Pacific and Asia (DIPWA)* has been proposed. This network will cover East Asia, Southeast Asia, Melanesia, Micronesia, Australia and New Zealand. The main office for this network has been proposed by the Center of Ecological Research, Kyoto University, Kyoto, Japan.

### *Ibero-American Region*

A proposal has been submitted by the chairman of the *Ibero-American Biodiversity sub-programme (CYTED)* to establish in cooperation with *Diversitas* a regional network for inventorying and monitoring biodiversity in the region.

## 5.2. ICSU

From the onset, *Diversitas* was launched by IUBS, in cooperation with SCOPE, and with the collaboration of IUMS and IGPB, all belonging to the ICSU family. This fact prompted the last ICSU General Assembly, held in Santiago de Chile, in October 1993, to

adopt a resolution commending *Diversitas*, and to sponsor the IUBS International Forum "Biodiversity, Science & Development. Towards a new partnership".

### 5.3. UNEP Global Biodiversity Assessment (GBA)

Within the framework of the Convention of Biological Diversity, UNEP's project *Global Biodiversity Assessment (GBA)*, as mentioned above, followed the same conceptual framework as *Diversitas*. In order to avoid duplication, the leaders and scientific advisory committees of the *Diversitas* themes were entrusted with the development of the various chapters of GBA. This has resulted in the organisation of a series of joint meetings, such as the synthesis meeting on Biodiversity Ecosystem Function held in 1994, in Asilomar, California, and the workshop on Origins, Maintenance and Loss of Biodiversity held in France, in November 1993. Also, the GBA section on Biodiversity Inventorying and Monitoring will be developed in cooperation with *Diversitas*.

## 6- Conclusions and Prospects

There is no doubt that at present biodiversity is a very fashionable word which covers a number of different possible approaches and perspectives, including emotional, aesthetic, ethical, scientific and developmental ones. Therefore, it is not surprising that there is such a proliferation of programmes dealing with biodiversity, both intergovernmental and non-governmental in nature.

In spite of this, *Diversitas* has its very definitive niche as the only scientific and global research programme covering the various levels of integration, from genes to populations, ecosystems and landscapes, up to a biospheric dimension. It is indispensable to draw attention to the unique specificity of *Diversitas*, while acknowledging and promoting all possible interactions with other national and international biodiversity activities.

Within IUBS, *Diversitas*, if considered at all different hierarchical levels, leads to a much needed unity of biology, with the diversity of all living beings and processes as a conceptual and operational leitmotif.

Moreover, biodiversity, in its relation with cultural diversity, provides the basis for a sustainable development and for a sustainable society.

The International Forum "Biodiversity, Science & Development. Towards a new partnership", draws its rationale from the above-mentioned principles. It intends, first of all, to put biodiversity in the correct scientific perspective, unravelling current myths. It also aims to demonstrate how biodiversity is essential for all productive sectors, such as agriculture, grazing, forestry, fishery and aquaculture, industry and international trade, as well as for landuse planning in urban, peri-urban, rural and natural systems, taking into account societal and ethical factors.

The unique feature of this Forum is that, unlike the Rio Summit where all actors did not interact with one another, here, all different partners (scientists, politicians, decision makers and in particular entrepreneurs and users) will have ample opportunity for a more interactive debate. This is the rationale for moving "towards a new partnership".

procedures of the three organisations concerned. SCOPE is, understandably, more involved in producing state of knowledge reports and syntheses; UNESCO, also very understandably, is particularly concerned with the promotion of its international network of biosphere reserves. In addition, the three constituencies of SCOPE, UNESCO and IUBS are different, and it is quite obvious that sometimes they cannot adequately perceive the logic of the other constituencies. It remains to be seen whether or not these different working procedures can be further harmonised in the future for the benefit of the overall *Diversitas* programme.

As a prospect for *Diversitas*, in particular as regards IUBS, some direction for the work to be undertaken should be proposed:

1) To define the concept, the functioning, the dynamics and the change of biodiversity in strictly scientific terms.

2) To introduce the concept of the diversity of life within IUBS as the leitmotif of the overall Union.

3) To help revitalise, promote and strengthen taxonomy all over the world.

4) To unravel the myths on biodiversity, and to raise public awareness on real scientifically sound issues.

5) To provide decision-makers with reliable information on biodiversity, thus facilitating a realistic basis for sustainable development.

6) To provide a global framework and guidelines for inventorying and monitoring biodiversity, to act as a catalyst for promoting all possible joint endeavours, and to synthesise data resulting from them.

7) To assure the unique niche and *modus operandi* of IUBS, but to remain open to all possible and workable interactions with other organisations.

## 7. Publications

Within the framework of the *Diversitas* Programme, a wide range of publications were produced, targeting various audiences concerned with biodiversity. These publications which include proceedings and synthesis books, monographs, reports, position papers, and information briefs and leaflets, are:

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Barbault, R. 1994. Biodiversity Dynamics and Environment: A Research Programme for the Rio Challenges. *Biology International*. **28**:18-22.

Barbault, R. 1994. Des baleines, des bactéries et des hommes. Editions Odile Jacob, Paris. 328 p.

Barbault, R. & Hochberg, M.E. 1992. Population and Community Level Approaches to Studying Biodiversity in International Research Programmes. *Acta Oecologica*. **13**:137-146.

di Castri F. 1990. Diversité biologique, notre bibliothèque vivante. *Revue des Deux Mondes.* Decembre 1990:34-52.

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Hawksworth D. & R.R. Colwell 1992. Biodiversity amongst microorganisms and its relevance. *Biology International,* 24:11-15.

Hawksworth D.L. & R.R. Colwell (Eds). 1992. Microbial Diversity 21: Biodiversity amongst microorganisms and its relevance. *Biodiversity and Conservation,* Special Issue 1 (4):221- 345.

Hawksworth D.L. & R.R. Colwell (Ed). 1994. Ecosystem Function of Microorganisms Diversity. Published by CABI, London (in press).

Heywood V. (Ed). 1994. Conservation of Biodiversity of Wild Relatives of Cultivated Plants and Domesticated Animals. *Biology International,* Special Issue (in press).

Hochberg, M., Clobert, J., & Barbault, R. (Eds.) 1994. Aspects in the Genesis and Maintenance of Biological Diversity. Oxford University Press, Oxford. (In press).

Kawanabe H., T. Ohgushi & M. Higashi (Eds). 1993. Symbiosphere. Ecological Complexity for Promoting Biodiversity. *Biology International,* Special Issue N°29, 86 p.

Lasserre P. , A.D. McIntyre, J.C. Ogden, G.C. Ray & F. Grassle (Eds). 1994. Marine Laboratory Networks for the Study of the Biodiversity, Function and Management of Marine Ecosystems: A Contribution to *Diversitas* Programme. *Biology International,* Special Issue (in press).

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Simpson B.B. 1988. Biological Diversity in the Context of Ecosystem Structure and Function. *Biology International*, **17**:15-17.

Solbrig O.T. 1991. *Biodiversity: Scientific Issues and Collaborative Research Proposals*, MAB Digest N° 9, 77 p. (Also translated in Chinese and published by the Chinese Academy of Sciences, CAS, Beijing, China).

Solbrig O.T. (Ed). 1991. *From Genes to Ecosystems: A Research Agenda for Biodiversity*, IUBS Monograph Series N°7, 124 p.

Solbrig O.T., H. van Emden & P. van Oordt (Eds). 1992. *Biological Diversity and Global Change*, IUBS Monograph Series N°8, 224 p.

Solbrig O. T. (Ed). *Biodiversity Function in Savanna Ecosystem*, Springer Verlag, Heidelberg (in press).

The Economist. 1991. Species Galore; and Counting Species, **7724:** 17 & 99-100.

TOTAL - La Fondation 1993. "*La Diversité: c'est la Vie*" This consists of an information brochure presenting biological diversity to the general public prepared in collaboration with the IUBS and UNESCO, and widely distributed (500 000 copies). Also translated in English, and a Spanish version is being prepared.

UNESCO 1992. *Diversitas*, The IUBS-SCOPE-UNESCO Programme on Biological Diversity: an information leaflet, 6 p. (In English, French and Spanish).

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*Biology International N° 29 (July 1994)*

# Developing the Bionomenclatural Base Crucial to Biodiversity Programmes

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*An efficient system for the regulation of names of organisms is crucial to the effectiveness of biodiversity programmes. The status of the five current Codes is reviewed, and a synopsis is provided of progress made towards reducing name changes other than for scientific reasons, harmonizing the codes, preparing a glossary of terms used, and developing lists and catalogues of names and works. The word "bionomenclature" is preferred to "biological nomenclature" when names applied to whole organisms (taxa) are being considered. Future actions that IUBS might take to strengthen and develop new initiatives are proposed.*

## The Need

The crucial issue as to how the organisms constituting the Earth's genetic resources are to be named and recorded, is all too easily eclipsed in the currently high level of international debate on issues related to the conservation and sustainable use of biodiversity. Yet it is essential that a satisfactory nomenclatural system be in place that can simultaneously optimize communication amongst all biologists and users of scientific names, minimize name changes not resulting from improved scientific knowledge, and reduce drastically the time the limited numbers of systematists have to devote to nomenclatural matters.

Without a sound nomenclatural system, the vast array of biodiversity and genetic resource initiatives at the international, regional, national, and local levels would become confused and frustrated. Uncertainties as to whether organisms represented by different names are actually distinct or not can occupy a specialist in the group concerned with very considerable work. Imagine, therefore, the problem this becomes not only to the ecologist, conservationist, crop protection specialist and breeder, but also to politicians and legal experts concerned with legislation for the protection of, or minimization of risks from, different organisms.

The International Union of Biological Sciences (IUBS) is the *de facto* focal point for biological nomenclature. The various international bodies concerned with biological nomenclature have traditionally all been scientific members of IUBS, although responsibility for those concerned with bacteria and viruses transferred to the International Union of Microbiological Societies (IUMS) on the separation of that Union from IUBS in 1980.

Major demands unforeseen even in 1984 are now being placed on the current nomenclatural systems by rapid advances in our understanding of relationships between organisms, especially through molecular biology, the needs of the electronic information industry, intellectual and indigenous peoples' property rights issues, and the rapidly expanding variety of biodiversity programmes. Recognizing this problem, and following a symposium organized by IUBS and the Systematics Association at the Third International Congress of Systematic and Evolutionary Biology (ICSEB III) in Brighton in 1985 (Ride & Younès, 1986), an IUBS Standing Committee on Biotaxonomy and Nomenclature was established at the 23rd General Assembly of IUBS in Canberra in 1988.

IUBS, together with the International Association for Plant Taxonomy (IAPT) and the Systematics Association held an international symposium on "Improving the Stability of Names: Needs and Options" at Kew in 1991 (Hawksworth, 1991), and later in the same year the 24th General Assembly of IUBS meeting in Amsterdam (Younès, 1992) passed a Resolution which endorsed the coordination of a programme to streamline and improve utility in biological nomenclature and encouraged increasing harmonization between the various Codes.

A synopsis of the action taken since 1991 in the furtherance of this Resolution by both the IUBS Standing Committee and the pertinent IUBS bodies follows.

## Status of the Current Codes

There are five Codes or sets of Rules concerned with different groups of organisms, Bacteriology (Sneath, 1992), Botany (Greuter *et al.*, 1994; covering all groups historically treated by "botanists", including algae, cyanobacteria, filamentous fungi, slime-moulds, some protists, and yeasts), Cultivated Plants (Brickell *et al.*, 1980), Viruses (Francki *et al.*, 1990), and Zoology (International Commission on Zoological Nomenclature, 1985; embracing all groups historically studied by "zoologists"). Each of these has independent traditions and derives authority from an appropriate international body affiliated to either IUBS or IUMS, and is revised periodically. The detailed contents of each of these Codes has been undergoing revision since the 24th General Assembly in 1991.

**Bacteria:** This Code was revised completely in 1976, and changes since then have been minor; the latest revision was issued in 1992 (Sneath, 1992). Some further issues relating to harmonization (*see below*) will be discussed by the International Commission on Systematic Bacteriology in Prague in July 1994.

**Botany:** A new edition, revised in accordance with decisions at the XV International Botanical Congress held in Yokohama in August-September 1993 has now been prepared (Greuter *et al.*, 1994).

**Cultivated Plants**: The International Commission for the Nomenclature of Cultivated Plants (ICNCP) plans to finalize a total revision of the Cultivated Plant Code following a symposium being convened in Seattle by the Commission in August 1994. The new edition is expected in 1995.

This change in mood in botany is reflected in a Resolution of the whole Congress which "urges plant taxonomists, while such work [*i.e.* exploring new avenues for increased stability] continues, to avoid displacing well established names for purely nomenclatural reasons, whether by change in their application or by resurrection of long-forgotten names". The draft for the new edition of the Zoological Code also places less emphasis on the priority of publication of names and more on their usage.

## Inter-Code Harmonization

The major event organized by the Standing Committee since 1991 was an "Exploratory Meeting on Harmonization Between Codes of Nomenclature", convened at Egham on 16-18 March 1994 in accordance with the Resolution of the 24th General Assembly of IUBS (*see above*), and with the support of the International Union of Microbiological Societies (IUMS), the International Association for Plant Taxonomy (IAPT), the Royal Society of London, and CAB INTERNATIONAL. It was particularly timely as in 1993 the XVI International Botanical Congress established a Special Committee on Harmonizing Codes.

The Exploratory Meeting included representatives of the organizations responsible for the production of all five Codes. The need to work towards increased harmonization, and to a unified Biological Code was embraced for the first time. Common ground was identified, and different practices were discussed in depth. A full report of the Meeting is published separately (Hawksworth *et al.*, 1994), but it is appropriate here to highlight in an abbreviated form seven of the 14 conclusions:

- It would be highly advantageous to work towards a unified system of biological nomenclature.

- While there are differences in procedures between the current Codes, which could not be reconciled for the nomenclature of the past without an unacceptable disruption of names in use, there is considerable scope for harmonization.

- The availability of lists of published names, and the registration of new names in bacteriology, botany, virology and zoology, will make possible the harmonization of nomenclatural procedures in biology.

- Considering the divergent rules and traditions concerning author citations for scientific names, the use of such author citations should be made optional (and be recommended only in a strictly taxonomic context).

- There is a need to develop common procedures for the nomenclatural treatment of fossils, with particular emphasis on form genera and other parataxa.

- The particular nomenclatural problems posed by ambiregnal organisms, that is those treated under different Codes, can be accommodated by small modifications to the existing Codes.

- As confusion can be caused by the existence of homonyms, that is identically spelled names, in use under the different Codes, authors of new generic names

should avoid proposing a name established under another Code, and provisions need to be introduced into each Code to disallow new generic names that are junior homonyms under any Code.

That there are real prospects for increased harmonization is evidenced by the XV International Botanical Congress in 1993 which approved several changes which tend to bring the Codes together: notably the use of the term "phylum" as an alternative to "division", the acceptability of cultures permanently preserved in a metabolically inactive state as nomenclatural types, accepting the concept of "suppressed works", and mandating Committees to reject and conserve names in most ranks for almost any reason in the interests of nomenclatural stability (*see above*).

## Terms used in Bionomenclature

An unfamiliarity with the concepts used in biological nomenclature, the number of unique terms, and words accorded special definitions, all constitute barriers to the biologist endeavouring to apply the Codes or fully appreciate a nomenclatural discussion. In order to at least alleviate in part this problem, the need to develop a glossary of terms in use in biological nomenclature was identified as a part of the forward programme of the IUBS Standing Committee on Bionomenclature and Taxonomy at the 24th General Assembly in 1991. This was echoed in the case of official terms in botany at the Nomenclature Section of the XV International Botanical Congress in 1993.

The Exploratory Meeting (*see above*) reviewed a preliminary compilation of the terms currently employed in the existing Codes and unofficial and obsolete ones encountered in the literature, obtained from a variety of sources. It recognized that harmonization of terms should be effected wherever possible, and in addition agreed to work towards a *Glossary of Terms Used in Bionomenclature*, including both official and unofficial terms. As a first step, the Meeting decided to revise the tabled document and issue it as a *Draft* (Hawksworth, 1994) to serve as a basis for critical discussion by those responsible for each Code.

Following inputs from the mandated committees, the objective would be to realize a *Glossary* recognized as authoritative by all five Codes and from which definitions of officially used terms would be incorporated unchanged into future editions of the individual Codes.

## Lists and Catalogues of Names and Works

The preparation of authoritative lists of names, whether all those that have been published or those in current use (NCUs) is a major undertaking. For example, one of the three NCU lists prepared for the XV International Botanical Congress in 1993 included 28 041 generic names and involved 219 botanists in its preparation (Greuter *et al.*, 1993a). The publication of this particular list within six years from the decision that such a list was desirable was a major achievement and brings credit to the dedication of its compilers and editors.

The funding of the preparation and production of catalogues and indexes of names and works, the essential reference points of biological nomenclature, has always been difficult to secure in both botany and zoology. The NCU list of generic names in botany was facilitated by grants from IUBS, IAPT, The Royal Society of London, several scientific members of IUBS, and in the final phase benefited from UNESCO's "Botany 2000" programme.

UNESCO "Botany 2000" also provided a grant for the International Legume Database & Information Service (ILDIS) to create a sample NCU list from its main species diversity database of all *Leguminosae*. The main database lists almost 17 000 taxa by the name accepted and preferred by the ILDIS taxonomic co-ordinators (Bisby *et al.*, 1994; Zarucchi *et al.*, 1993). In the NCU sample, the tribe *Vicieae*, the names covered include all of those currently accepted in ILDIS together with names in current use in alternative taxonomies.

It is encouraging that in these days of high-profile multi-media species diversity information services, UNESCO should be willing to support the associated and much-needed infrastructure on nomenclatural documentation. As such data is of value to scientists and users of scientific names in all countries, international funding is especially appropriate. Substantially more investment in such initiatives is required if NCUs down to species level are to be completed for most groups of organisms in the foreseeable future. Yet, such authoritative reference lists of names are vital to the effectiveness of biodiversity programmes.

The International Organization for Plant Information (IOPI) was established in Canberra in September 1991 as a consequence of discussions at a symposium held in Delphi in 1990 on "Designs for a Global Plant Species Information System" supported by the Taxonomic Databases Working Group (TDWG), CODATA, IUBS, ECCD, the Linnean Society of London and the Systematics Association (Bisby *et al.*, 1993; Burnett, 1994). It is committed to providing dispersed, computerized information concerning plants and their attributes and its first project is a *Global Plant Checklist* of vascular plants. This will be compiled as an on-line, electronic, relational database which will, therefore, be both accessible and infinitely expandable. Its other most distinctive feature is that the nomenclature and distributional data will be edited and agreed by consensus amongst teams of taxonomists world-wide; several hundred have already agreed to participate. A detailed database design and project plan are available (Wilson, 1994). This database should provide a valuable working tool for nomenclaturalists and help to bring more stability. The second agreed IOPI project is the preparation of an electronic *Species Plantarum*, details of which are still under discussion.

A variety of botanical master-inventory databases, including TROPICOS (Missouri Botanical Garden), ILDIS, IMI, and IOPI are participating in the IUBS Commission on Taxonomic Databases (the Taxonomic Databases Working Group, TDWG). In addition, BIOSIS (TRF), the Deutsche Sammlung von Microorganismen (DSM), International Commission on the Taxonomy of Viruses (ICTV), the European Taxonomic Information project (ETI), the International Organization for Paleobotany (IOP) Fossil Record, and CAB INTERNATIONAL are participating in the associated CODATA Commission for Standardised Access to Biological Data.

In the case of the fungi, the International Mycological Association (IMA) and the International Commission on the Taxonomy of Fungi (ICTF) were amongst the sponsors of a NATO Advanced Research Workshop held in Paris in May 1993 which reviewed the current listings and arrangements of all 6000 + ascomycete generic names. This eclectic approach to developing an evolving system of classification, initiated in 1982 and now publishing a revised outline at four-yearly intervals, may serve as model for other groups (Hawksworth & Eriksson, 1994).

## Bionomenclature *vs.* Biological Nomenclature

The word "bionomenclature" has been used here in preference to "biological nomenclature" as the latter includes all things which biologists might wish to name, for example including biochemical and genetical terms and names of parts of cells. The publication Biological Nomenclature (Institute of Biology, 1989) in which only two of 48 pages are devoted to bionomenclature illustrates the scale of the problem.

In order to minimize future ambiguity, I suggest that "bionomenclature" is used as the preferred term where it is aspects of the naming of whole organisms (taxa) that is under consideration.

## The Future

The period since the 24th General Assembly of IUBS in 1991 has been a dramatic one for bionomenclature. A fresh and increasingly pragmatic attitude has become evident across the different international bodies charged with its operation and development. However, there is no room for complacency if the vision now developed is to be turned into reality in the foreseeable future. The role of IUBS (and of IUMS) will be crucial in the period to the 26th General Assembly in 1997. The following actions are amongst those that requiring priority attention during this next term:

- Establish an inter-union IUBS/IUMS International Commission on Bionomenclature (ICB) at the 25th General Assembly as recommended by the Exploratory Meeting on Harmonization Between Codes of Nomenclature.

- Provide resources to enable the ICB, once established, to work towards the production of a harmonized bionomenclatural Code that could be applied to all organisms from a date to be determined.

- Sponsor a session to review progress towards harmonization and other aspects of bionomenclature at the International Congress of Systematic and Evolutionary Biology (ICSEB V) in Budapest in 1996.

- Facilitate the preparation, production and funding of lists of names in current use and other catalogues of names, to be made accessible through hard copy and electronic media, by securing support from the donor community and other sources.

Sponsor the completion and publication of an authoritative Glossary of Terms Used in Bionomenclature for use in all groups of organisms.

Promote awareness of the fundamental importance of bionomenclature and biosystematics to biodiversity and other aspects of pure and applied biology through meetings and publications.

I submit these topics for consideration by the Scientific Programme Committee to be convened during the 25th General Assembly of IUBS.

## Acknowledgements

It is a pleasure to record the gratitude of the IUBS Standing Committee on Biotaxonomy and Nomenclature to Dr T. Younès for his encouragement and enthusiastic support of its work, and for being instrumental in securing essential funding. Support has been received for various parts of the programme from UNESCO, ICSU, IUBS, IUMS, IAPT, CAB INTERNATIONAL, International Cell Research Organization, International Mycological Association, The Royal Society of London, and the Systematics Association. Dr F.A. Bisby, Sir John Burnett, Dr J. McNeill, Dr P.K. Tubbs, and Dr T. Younès kindly commented on or provided material for inclusion in this report.

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*Biology International N° 29 (July 1994)*

# Global Master Species Databases and Biodiversity

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## Abstract

*Master species databases are in the process of being developed for a number of major groups of organisms: bacteria, protists, arthropods, molluscs, fishes, birds, fungi, plants and fossil plants. Whilst there is a long way to go before completion, these projects illustrate that the process of creating master listings is feasible and can be successful. Master species databases would provide invaluable services to the countless species inventory projects being undertaken worldwide, as a rapid way of verifying species lists, checking names for uniformity and as a source of pre-prepared electronic species checklists. The IUBS Taxonomic Databases Working Group (TDWG) has made substantial progress with providing a framework of standards and formats for data exchange and intercompatibility among plant databases. A discussion as to whether its work should be extended to include animal and microbial databases as well as those for plants will be held at the IUBS International Forum in Paris on September 6 1994. A related meeting of the CODATA Commission on Standardised Access to Biological Data (STABD) will bring together the organisers of the major master species databases for all taxa in Chambéry France on Sepember 20th 1994.*

## Introduction

Many of those working in biodiversity, biotechnology, conservation and genetic resources seem unaware of the revolution, albeit a slow and silent one, that is occurring in global species diversity databases and the provision of systematic data. This article is intended simply to alert the community to what is already happening and point out the direct relevance to biodiversity assessment programs worldwide. Indeed greater awareness and participation in these projects could already yield very considerable savings of time and effort in many individual biodiversity projects.

## Global Master Species Databases

Of the many sorts of systematic databases being developed, the most significant for the general biologist are the global master species databases being developed for a range of different taxonomic groups: the viruses, bacteria, protists, fungi, molluscs, arthropods, fish, plants, fossils etc. These are the ones in which data on species prepared carefully by specialists are made available to biologists at large. As a minimum they provide a master list of the species that exist. As they progress some are reaching completeness (listing all known species in the world) and full classificatory co-ordination (that is internal consistency with a responsibly selected system of preferred systematic treatments). Many

give accepted scientific names, synonyms and common names. They can thus be used to find out how many species there are and to list them (say in a selected genus), to locate a responsible view of the "correct name" for each species, to locate these species from synonyms, to check the spelling of a name, and find where the species fits in the taxonomic system.

Some of these databases are master species databases only, with just the systematic and nomenclatural data. Others amplify this with geographical and biological data on the species either as text screens, as structural database fields or, increasingly, as images. The user can thus search for the species of a particular region, or see the worldwide distribution of a chosen species. The biological data, however provided, give the user access to descriptive or biological data about the species, either to satisfy an enquiry by the user, or to assist the user in confirming an identification. In those databases searchable on biological fields, the user can conversely search for the species with certain combinations of attributes.

I list some examples of existing global master species databases below. All are at different stages of development. Some have very different data structures and software, and several were started with quite different objectives.

DSM. *List of Valid Bacterial Names* (Deutsche Sammlung von Mikroorganismen and Zelkulturen, Braunschweig).

BIOSIS TRF. *BIOSIS Bacterial Taxonomic Reference File* (BIOSIS Philadelphia).

ETI. *Linnaeus Protist* (also Mollusc and Bird systems) (Expert-Center for Taxonomic Identification, Amsterdam).

ANI. *Arthropod Name Index.* (CAB International, Wallingford).

BIOTA. World List of Insect Species (United States Dept. of Agriculture, Systematic Entomology Laboratory)

Eschmeyer, W.N. *Taxonomic Database for Fishes.* (California Academy of Sciences, San Francisco).

IMI. *Species Fungorum and Dictionary of the Fungi Database* (International Mycological Institute, Egham).

TROPICOS. *The Botanical Database of the Missouri Botanical Garden* (Missouri Botanical Garden, St Louis).

ILDIS. *International Legume Database & Information Service* (ILDIS Phase 1, Version 2.0) (ILDIS Co-ordinating Centre, Southampton).

CITES. *CITES Cactaceae Checklist* (Royal Botanic Gardens, Kew).

IOPB. *The Plant Fossil Record Database Version 2.0* (International Organisation of Palaeo-Botany, London).

Many other such databases are under development. They include the IOPI *Global Plant Checklist* to cover all vascular plants (Burnett, 1993; Wilson, 1994), and the products of the IAPT/IUBS *Names in Current Use* program which lists species names in certain families (Greuter *et al.*, 1993).

Much has been made of the very varied estimates of how many species exist on earth (Wilson, 1988; Stork, 1988). Indeed it is said that there are "far too many to list". However the number of species actually known to taxonomists today is merely about 1.8 million - in magnitude a listing equivalent to the contents of just 8 or 9 telephone directories! Indeed one can argue how surprising it is that biologists did not long ago institute a master listing of species. The real reason why such lists are not available relates less to the difficulty of handling the numbers and rather more to the difficulties specialists have in providing agreed or preferred taxonomies.

The purpose of the above list is to illustrate not only that the task can be done, but that a major start has already been made.

## How do Global Master Species Databases assist Biodiversity studies?

A common feature of many national biodiversity programs, non-government programs, national park and nature reserve programs and programs on particular groups (eg. on birds, cacti or orchids) is that they undertake the creation of an inventory, usually as a database. Into these will be copied the names of the relevant organisms taken from museum/herbarium specimens, from published floras and faunas, and from field surveys. The inventory of what is there will be built up from the bottom. How can such a process, repeated countless times around the world be assisted by access to global master species databases?

The most important aspect could be verifying the existence and currently accepted name of each species. For a variety of reasons the recent history of systematic discovery and research has led to the proliferation of local, national and regional published works. As steps in reporting the knowledge of species in the wild this is exactly as it should be. But a side-product of this is the freedom of local works and local specialists to make their own choices on adopting classifications, on introducing changes instituted elsewhere in the world, on segregating local forms and endemics. The combined effect however, is that inventories created from local and national, even regional published works are extremely problematic when put side by side. If 10%, 20% or even 30% of organisms are treated differently how can the inventories be compared? But if all the organisms (or presently, a fraction) can be checked against a globally complete and taxonomically co-ordinated list, then the same species in different lists under different names, disparities caused by different treatments, and other inconsistencies between lists can be located. These matters are important in the handling of intellectual property rights, quarantine, trade and conservation regulation, as well as agricultural and biotechnology development.

Local and national projects may well have good reasons to hold the main version of their inventory using their own view of the taxonomy, but by referring to global lists they may also create a "standardised" version which will then be comparable say between one country and another, or between a montane rainforest stand and a similar one in another continent.

A second use depends on whether the project in question wishes to use the "standardised" version of a global list for inclusion in its own inventory database. If it does, there may then be the time-saving possibility of downloading all or part of the species checklist from the master database. The saving is simply that species names, authorities, synonyms, and higher taxon names will be already correctly entered and checked, already correctly placed in the classification, and already "compatible" with other databases: establishing this data afresh, both acquiring the data, entering it, and editing it to a high standard, are known to be very time-consuming tasks. For example a user of the ILDIS database on Leguminosae has installed a copy of the ILDIS dataset (Zarucchi *et al.*, 1993) within the user's own database. When new records are entered, those for legume species can use ILDIS names and data, selected from within the database, without typing any names and with synonomy links already made.

## TDWG and Standards amongst Systematic Databases

Species databases are in fact just the tip of the iceberg: databases are being used for a wide array of information handling tasks in species diversity programmes. To many working biologists these may be seen as "behind the scenes" internal workings - specimen databases in museums and herbaria, type register and nomenclature databases, descriptive databases used for taxonomic analysis, geographical distribution databases, bibliographic databases of taxonomic and nomenclatural citations, etc. Whilst each may have a different function there are many individual elements that may occur in many or each of these, such as scientific names, names of geographical areas etc.

To function efficiently we need to transfer data between the databases or to write software that can address them simultaneously. Downloading a species checklist for use in a local inventory would be an example. It was to this end that the Taxonomic Databases Working Group (TDWG) was formed in 1985 to identify and in some cases to create mechanisms for data exchange amongst botanical databases. The group has met for a 2 or 3 day workshop annually, became a Commission of IUBS in 1988, and in 1990 ran the Delphi symposium "Designs for a Global Plant Species Information System" funded by the European Community and the U.S. National Science Foundation (Bisby *et al.*, 1993).

Work at TDWG on data exchange has focused on three levels of standards or compatibilities:

i) data models

ii) data structures suitable for particular data areas (eg. plant names)

iii) dictionaries of elements for common use (eg. author names and abbreviations, geographical areas)

iv) data exchange formats (eg. species checklists, descriptions, images).

A brief list of TDWG Standards is given in Appendix 1.

## Extending TDWG to encompass animal and microbial databases

At present TDWG addresses species diversity databases *in plant sciences*. Those taking part are principally botanists and mycologists, although representatives of zoological and all-taxon organisations have attended regularly. Yet few of its discussions, or of its technical standards are actually restricted to plants.

It is now proposed that, with the support of the IUBS General Assembly, TDWG might expand its remit to cover taxonomic databases of *all groups of organisms*. To test the reaction and level of support from databases organisers, there will be a presentation and discussion during the IUBS General Assembly in Paris (5-9 September 1994). The presentation "The Taxonomic Databases Working Group: ideas on encompassing databases of all groups of organisms" will be on Tuesday 6 September 1994 at UNESCO Headquarters in Paris in parallel with Panel 2 of the IUBS International Forum. ( Further details of TDWG are available from Mr G F Russell (TDWG Secretary), Department of Botany, NHB 166, The Smithsonian Institution, WASHINGTON, DC, 20560, USA.)

## Collaboration with CODATA

Another member of the ICSU international organisations has begun to take an interest in fundamental scientific data in biodiversity - CODATA, the ICSU *Committee on Data for Science and Technology*. CODATA has an active Commission on *Standardised Access for Biological Data* (STABD) led by Dr Lois Blaine of the American Type Culture Collection. This Commission has held a series of workshops looking at the accessibility of data between sectors amongst the biological disciplines. One of several problems revealed has been the unfulfilled demand by molecular and biotechnology laboratories for access to global master species databases and classification systems. The next meeting of the STABD Commission will be at Chambéry in France (during the CODATA 14th International Conference *Data and Knowledge in a Changing World*, 18-22 September 1994) when the organisers of the principal global master species databases listed above will be invited for discussions on possible joint developments. Officers of the IUBS Taxonomic Databases Working Group and of the CODATA STABD Commission are working together to co-ordinate these activities. (For details of the CODATA 14th International Conference contact CODATA '94 Secretariat, ITODYS, Université Paris VII, 1 rue Guy de la Brosse, 75005 PARIS, France, and for the CODATA STABD Commission, contact Dr Lois Blaine, ATCC, 12301 Parklawn Drive, ROCKVILLE, Md, 20852-1776, USA.)

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## Acknowledgements

I am indebted to Dr. Ellen Farr, Prof. D.L.Hawksworth, Dr. R.M.Polhill, Dr. T.Younès and Dr. J.L.Zarucchi for their comments on this report.

## Appendix 1. TDWG Standards.

### A) Existing Standards endorsed by TDWG

Authors

Brummitt, R.K. and C.E. Powell, Eds. 1992. Authors of Plant Names. Kew: Royal Botanic Gardens. 731 p. *(Names and abbreviations for botanical authors.)*

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Bridson, G.D.R. and E.R. Smith. 1991. Botanico-Periodicum-Huntianum/ Supplementum Pittsburgh, Hunt Institute for Botanical Documentation. 1068 pp. *(Supplement to 1968 Edition.)*

Lawrence, G.H.M., et al., Eds. 1968. Botanico-Periodicum-Huntianum. Pittsburgh: Hunt Botanical Library. 1063 pp. *(Abbreviations for titles of periodicals.)*

Stafleu, F.A. and R.S. Cowan. 1976+. Taxonomic Literature, 2nd Ed. Vols. 1-7. Utrecht: Bohn, Scheltema & Holkema. *(Abbreviations for titles of books.)*

Herbarium Code Designations

Holmgren, P.K., Holmgren, N.H. & Barnet,L.C. 1990. Index Herbarium Pt.1 (Ed. 8). *Regnum Vegetabile* Vol. 120.

Phytogeographic Units

Takhtajan, A. 1986. *Floristic Regions of the World.* University of California Press.

Economic Use Descriptors

Cook, F.E.M., & Hastings, L.H. 1994. *Economic Botany data collection standards*. Royal Botanic gardens, Kew.

## B) TDWG Published Standards

Progress with standards created by TDWG has been disappointingly slow, a function both of the wide input and consultation needed, and of dependence on volunteered effort from already busy experts. However, the following list gives the standards published and others adopted but still to be published:

Data Exchange

Botanic Gardens Conservation Secretariat. 1987. The International Transfer format for Botanic Garden Plant Records. Plant Taxonomic Database Standards No. 1. Pittsburgh: Hunt Institute for Botanical Documentation. *(A standard adopted by botanic gardens for recording and exchanging specimen data.)*

World Geography

Hollis, S. & Brummitt, R.K. 1992. World Geographical Scheme for Recording Plant Distributions. Plant Taxonomic Database Standards No. 2. Pittsburgh: Hunt Institute for Botanical Documentation. *( A standard widely used by taxonomic databases for listing distributions covering land areas of the world)*

Names of Taxa

Bisby, F.A. 1994. Plant Names in Botanical Databases. Plant Taxonomic Database Standards No. 3. Pittsburgh: Hunt Institute for Botanical Documentation. *(A standard describing the minimum set of plant fields needed to specify plants precisely.)*

## C) Standards in Preparation by or with TDWG

Habitat, Soil and Landscape Descriptors

TDWG Subgroup seeking a simple system that can be used worldwide to categorize the habitat, soil type and landscape in which a plant occurs. *(Contact the convener, Dr. J. M. Lock, at the Royal Botanic Gardens Kew. For a provisional document see: Lock, J.M. 1991. Ecological Information for Taxonomic Databases. Bulletin of the British Ecological Society 22: 99-102).*

Life-form Descriptors

TDWG Subgroup attempting to identify a small set of universal descriptors that can be applied to the life-forms of plants. Contact the convener, Dr. R.J. Pankhurst, at the Royal Botanic Garden Edinburgh.

Plant Occurrence Descriptors

"Plant Occurrence and Status Scheme (POSS)." *(TDWG has adopted the standard prepared by Christine Leon, Duncan Mackinder, Peter Rooney and Hugh Synge, at the World Conservation Monitoring Centre, working with a TDWG Subgroup. It provides a scheme for recording the status of a plant in an area.)*

Data Exchange

TDWG Subgroup seeking an accessions exchange format for specimen data. Contact the convener, Dr. J. Beach, through the TDWG Secretariat.

"XDF. A Language for the Definition and Exchange of Biological Data Sets." *(TDWG has adopted this standard prepared by Dr. R. Allkin, Royal Botanic Gardens, Kew, and Dr. R J. White, University of Southampton working with a TDWG Subgroup. XDF is a data definition language that can serve as a medium for defining transfer formats for use between databases with incompatible formats.)*

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# IOPI and the Global Plant Checklist Project

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## Introduction

There is an implicit assumption in the many admirable and essential programmes now under way or in process of development that inventories of already described organisms are both available and readily accessible. This is by no means always the case. Moreover, apart from the relatively small numbers of groups for which modern, world-wide monographs exist, contemporary knowledge suffers from various defects. Unhappily, the occurrence of the same name in different plant or faunal lists is no guarantee that the same taxon is being described! The reasons for this are well known: different authors hold differing species concepts, voucher specimens are not available and published descriptions are not always sufficient for accurate comparisons, while many workers have operated, and still operate in some degree of isolation, and so on. There is a real danger that our proper concern to describe and conserve the unknown will be both hindered by, and result

in the neglect of, the accuracy, effective systematization and ready availability of existing knowledge. Such systematization complements studies on biodiversity and is an essential working tool for its investigation.

A contribution to avoiding such neglect and of providing a working tool for biodiversity studies is the Global Plant Checklist of vascular plants, the International Organization for Plant Information's (IOPI) first, basic project.

IOPI is a voluntary, international organization established at a meeting of taxonomists and computer specialists in Canberra in September 1991. Accounts of its origins and establishment have been published elsewhere (Burdet, 1992; Burnett, 1993). The membership, which continues to increase, includes over 100 institutions throughout the world and many hundreds of individuals are involved in its activities. A wider representation from Africa and Asia is being sought. It is committed to collating and providing dispersed, computerized information concerning plants and their attributes - conservation status, chemistry, distribution, ecology, genetics and multifarious uses, etc. The Global Plant Checklist (GPC Project) is a list of vascular plants of the world together with their general distribution and access to synonyms, etc., compiled as an on-line, electronic, relational database. It is already under way but appreciable, additional funding will be needed to complete the project and maintain the database thereafter. The time for completion and publication of the first, hard copy edition is five years from the provision of adequate funding: the electronic database will be accessible, on-line, from the start.

The GPC is basic in the sense that it provides the essential "skeleton" to which other information can be attached. This could be new information derived from biodiversity studies, information concerning a species' conservation status, or any of its other attributes. The database can be continuously updated or expanded. Because it is relational, information can readily be brought together and compared or contrasted. This provides a powerful tool for investigating a variety of ecological and biogeographical problems, of looking for phytochemical patterns, genetical properties or for improving existing taxonomy.

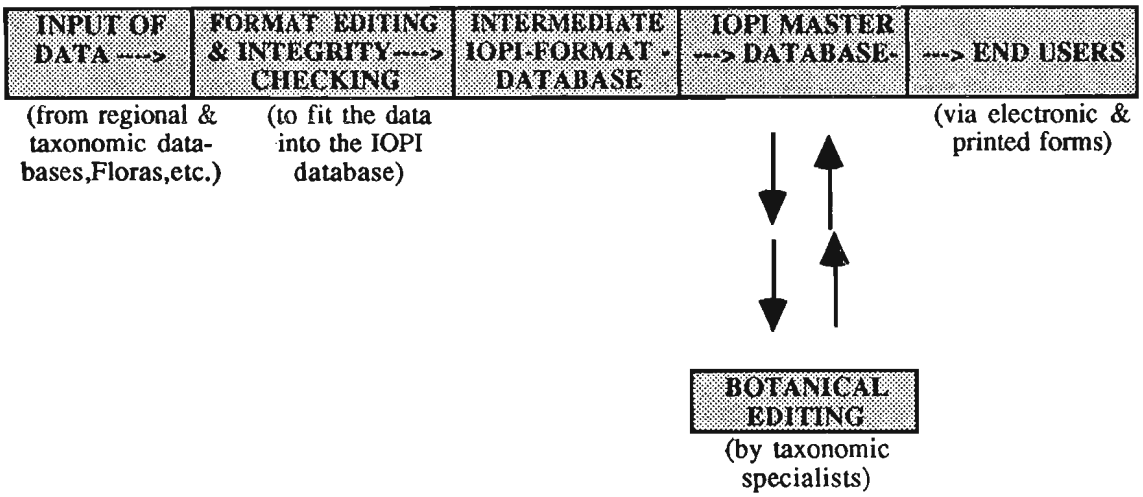
## The Project Plan

How will the GPC be created? A detailed Project Plan has been prepared (Wilson, 1994) over the last two years through the open collaboration of many botanists involving meetings in Australia, Japan, Mexico, Switzerland, the U.K., and U.S.A. That plan is now being implemented so far as the limited funds presently available to IOPI permit. Hitherto IOPI has relied on funding in-kind amounting to about US$1.5 million over three years from the budgets of various institutions and the pockets of its participants. This, at least, speaks for the enthusiasm the project has engendered.

Many hundreds of specialist taxonomists throughout the world will be involved, largely voluntarily, in the first instance. There is, therefore, a major logistic and management problem quite apart from the biological issues involved! Two groups, with multinational membership, are coordinating the work; a **Checklist Committee**, convened by Karen Wilson of RBG Sydney (originally by David Hunt of RBG Kew) and an **Information Systems Committee**, co-convened by Walter Berendsohn of Berlin Herbarium and Garden and Richard Pankhurst of RBG Edinburgh (originally by Catherine Zellweger of the Conservatoire and Botanic Garden in Geneva). The former Committee is responsible

for organizing botanical aspects, the latter has designed the database and established an Internet connection and related services.

The procedure to be adopted in preparing the GPC is diagrammed below.




The basic data will be derived from existing plant databases, of which at least 300 already exist, through scanning existing regional and local floras and, of course, from monographs and family checklists such as that for the legumes (Fabales) currently being produced by ILDIS or the *CITES* list of *Cactaceae*. On receipt, the raw data are first converted to the GPC format. The primary taxonomic unit included is the Species but allowance can be made for incorporating infraspecific categories. Initially, the recently published Kew list of plant families and genera will be used as a framework but, as the project proceeds, a single preferred taxonomy will be selected by collaborating specialists for each family working through an IOPI taxonomic coordinator and reviewed by an international panel. Alternative names will be given where appropriate and access to both preferred and alternative names will be possible. A working group of the Checklist Committee, under Frank Bisby of Southampton University - the Data and Definitions and Standards group - has been responsible for drawing up precise descriptions of the fields for the dataset. The minimum, initial, data set will be:

- IOPI preferred scientific name; usage; name components; author(s); inter-specific/generic hybrid symbol; infraspecific or aggregate species indicator.
- Acceptable alternative name(s)
- Synonyms (*s.l.*)
- Name of IOPI taxonomic coordinator; taxonomic notes; source, supplier's name and date of submission to and incorporation into GPC database
- Comments (short optional text on aspects of taxonomy/geography of taxon)
- Geographical occurrence; area; summary of geographical distribution
- Status in areas occupied

A distinctive feature of the GPC is that the formatted raw data will then undergo botanical/taxonomic editing involving critical assessment by relevant family/monographer specialists, working as a group if relevant, to achieve the best available consensus. This is

designed to ensure that only the same and most acceptable contemporary name is given, and used worldwide, to the same taxon. It should remove many of the anomalies and errors in existing lists although it will not necessarily involve the final determination of the correct name and a complete taxonomic treatment. It will, however, provide sufficient information for further taxonomic work if that is thought necessary. Nancy Morin of Missouri Botanical Garden convenes a Taxonomic Resources Network working group which is responsible for identifying appropriate collaborating taxonomists and inviting them to join the project. Several have already been approached and the response is gratifyingly positive although many more collaborators will be needed eventually. Data so edited is then incorporated in to the GPC master database which is available on-line to members of IOPI. Thus it will be possible for the GPC to be updated continuously at various sites in the light of changes or new information.

The data definitions group have worked closely with the Information Services Committee on the design of the database itself. This Committee has already designed an appropriate, expandable electronic database which is now ready for prototype testing. It also maintains a Database of existing Plant Databases at RBG Edinburgh. This is now sufficiently large and comprehensive for a first hard copy edition to be published and made available generally. An electronic IOPI network using Internet with gopher access has also been established and plans are underway to link it with the general biological network BIN 21. The Committee has also established an electronic Common Directory for all IOPI activities in which relevant documentation is deposited but can be consulted at any time by *bona fide* workers. The "master database" will, therefore, be effectively dispersed and can be sued anywhere via Internet. However, changes can only be made through the recognized and controlled IOPI editing procedure.

These procedures will culminate in the production of hard copy and an Editorial and Products working group under Herve Burdet at the Conservatoire and Botanic Gardens in Geneva is responsible for planning the forms of publication which could include hard copy and CD ROM products. The production format has not been decided finally but could well approximate to that in Figure 1.

**Kallstroemia pubescens** (G. Don) Dandy in Keay, *Kew Bull.* 10:138 (1955). (Zygophyllaceae)

Bas.: *Tribulus pubescens* G. Don
Syn.: *Kallstroemia minor* Hook. f., K. *longipes* Rydb.

Native to Central and northern S. America (south to Peru) and West Indies; naturalised in Florida, West Africa and India
Native: Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama,Puerto Rico, Jamaica, Lesser Antilles (Virgin Is., Leeward Is., Windward Is., Tobago, Curaçao), Colombia, Venezuela, Ecuador, Peru (Porter, 1969).
Naturalised: Florida (Porter, 1969), Ghana (Keay, 1955), Nigeria (Keay, 1955), India (Bennet, 1965).

*Taxonomic Coordinator: K.L. Wilson, NSW, Feb. 1994. Geographic Coordinator: K.L. Wilson, NSW, Feb. 1994.*

Figure 1. Example of possible format of printed output of IOPI Global Plant Checklist, which will summarise the more detailed information held in the IOPI database. (Bold face indicates IOPI-preferred names, *italics* synonyms.)

This group currently produces the newsletter, *IOPI News*, which is available also *via* Internet.

Finally, a User Liaison working group, convened by Scott Peterson (USDA, Baton Rouge) is concerned with identifying potential users and to ensure that their needs and views are both canvassed, and, as far as possible, met.

## Further Developments

IOPI has already decided to sponsor and take responsibility for a Species Plantarum Project (SPP). This was originally initiated by some of the major taxonomic institutions but deferred in favour of the production of the GPC which is seen as having an overriding priority. A Steering Committee convened by Dick Brummitt of RBG Kew is charged with the task of recommending a detailed project plan by 1995. Obviously both the GPC and SPP Committees will work in concert and their activities will be closely coordinated. Discussions have also commenced with a view to extending the GPC to include the non-vascular plants and the Fungi. There are obvious advantages if a common database format can be agreed for all plant groups and the fungi. Another urgent requirement is to expand existing conservation databases such as that held by WCMC and, hopefully, to assist in improving them. The addition of phytochemical and nuclear sequence data to the basic GPC would provide a new impetus both to the chemical exploitation of the plant world and to the unravelling of its phylogeny. But all these exciting possibilities are for the future. The overriding requirement is to establish the GPC as soon as possible as an effective working tool for all botanists and those others concerned with plants and their attributes.

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# ICMAP
# A New International Organization for Medicinal and Aromatic Plants

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In recent years there has been a resurgence of interest in medicinal and aromatic plants both in the developing and developed worlds. Amongst the topics of concern have been the need for establishing better standards for quality control, improved methods of harvesting and marketing, the need for germplasm conservation, the introduction and

domestication of new crops, consideration of questions of intellectual property rights and the application of biotechnology. Particularly in the case of medicinal plants, numerous handbooks on the species used in particular countries (e.g., Jain and DeFilipps, 1991; Duke and Ayensu, 1990) have been published as well as workshop and conference proceedings (Akerele *et al.*, Mota and Baeta, 1987) and guidelines (WHO, IUCN, WWF, 1993).

Although several committees or working groups have been in existence, including the IUBS Working Group on Medicinal Plants, the need for much more effective international cooperation between those engaged in different aspects of these groups of plants has been voiced on several occasions and as a consequence of various discussions the decision was taken by a group convened by IUBS to establish an International Council for Medicinal and Aromatic Plants.

## From WOCMAP to ICMAP

The establishment of ICMAP has its antecedents in the organization of a World Congress on Medicinal and Aromatic Plants (WOCMAP), itself an idea born during a discussion in 1987 between Professor P. Tétényi, then director of the Medicinal Plant Research Institute at Budakalasz, Hungary, and the Secretary General of the International Society for Horticultural Science (ISHS), Ir. H.H. van der Borg. Subsequently contacts were made with several organizations to ascertain if they were prepared to support the idea of bringing together in a congress different groups involved in medicinal and aromatic plants such as scientists, production and marketing specialists and consumers, who normally never meet each other.

A further development was the decision at the International Botanic Congress in Berlin in 1988 to merge the IUBS Working Group on Medicinal Plants and the Section on Medicinal and Aromatic Plants of ISHS. As a result of the various discussions with not only IUBS but the International Union of Pharmacology (IUPHAR), International Pharmaceutical Federation (FIP), UNDP, UNESCO, the CEC, FAO, and the International Center for Advanced Mediterranean Agronomic Studies (CIHEAM), a decision was made to go ahead and organize the first WOCMAP. An International Organizing Committee and an International Scientific Committee were established and preparations made for the Congress. To underline the need for cooperation between countries, universities and institutes, Maastricht was chosen as the venue as the town formed the center of a Euro-region where French, German, and Dutch speaking peoples are neighbors and where the universities of Liège, Aachen, and Maastricht already had many contacts.

The first World Congress on Medicinal and Aromatic Plants for Human Welfare - WOCMAP - was held in Maastricht from 15 to 19 July, 1992, and attracted about 350 participants from 56 countries. All the afternoon workshops attracted many participants and the discussions were lively, leading to the positive results in the form of a series of resolutions. The proceedings (WOCMAP 1993) were published in *Actae Horticulturae* as numbers 330, 331, 332, 333, in 1993. The final recommendations were as follows.

*Genetic resources and diversity of medicinal and aromatic plants must be classified and conserved through protection of natural sites and through development of tissue culture and other preservation techniques.*

*A new legal and ethical framework that will protect and regulate the use and management of genetic material of medicinal and aromatic plants needs to be established.*

*Quality plant material from sustainable production systems should be assured through the development and use of Good Agricultural Practices.*

*A standardized "way bill" for medicinal and aromatic plants needs to be developed and utilized to provide a verifiable record of plant material.*

*More financing and research should be directed towards enabling producer countries to locally process medicinal and aromatic plant material.*

*National acceptance and approval of herbal medicines should be based on the "Guidelines for the Assessment of Herbal Medicines" as developed by WHO.*

*Pharmacological and clinical trials should be conducted according to the directives outlined in the "Good Laboratory Practice" and the "Good Clinical Practice" of WHO.*

*Phytopharmaceuticals available to physicians should be botanically and phytochemically defined.*

*The preparation and publication of national herbal pharmacopoeias and the location of information data bases pertaining to medicinal and aromatic plants needs to be supported.*

*An international board for medicinal and aromatic plants should be established to stimulate cooperation among various international organizations working with medicinal and aromatic plants.*

Arising out of the last recommendation, a preparatory meeting was convened at IUBS headquarters in Paris in July 1993 of representatives of organizations interested in medicinal and aromatic plants. Strong support was given to the aim of setting up an international body in this area and it was formally decided to establish an International Council for Medicinal and Aromatic Plants (ICMAP), as a non-profit-making, non-governmental organization, with the aim of improving communication among the many international bodies that have an interest in medicinal and aromatic plants and stimulating action and cooperation among them. It would maintain its links with IUBS and in due course be proposed for admission at the General Assembly of IUBS in 1994 which would decide on the formal status of ICMAP.

A second meeting of ICMAP was held at IUBS headquarters in Paris in February 1994 at which a bureau was elected, charged with the task of establishing the necessary structures and programme of activities for the organization. Professor Vernon Heywood (Reading) was elected President, Professor A. Bandoni (Buenos Aires) and Dr. N. Verlet (Nyon) as Vice-Presidents, and Ir. H.H. van der Borg (Wageningen) as Secretary.

The Bureau has met twice and proposed that the Mission of ICMAP be "to promote international understanding and cooperation on the role of medicinal and aromatic plants in science, medicine, and industry". A formal constitution is in preparation. It is also agreed that WOCMAP-2 should go ahead in 1997 and negotiations regarding a venue are in hand. Below listed are the main activities proposed for ICMAP.

1. The preparation of WOCMAP-2 (and future congresses).
2. The development of the international membership of ICMAP, of organizations and national representatives.
3. The establishment of a clearing house of information on medicinal and aromatic plants.
4. The preparation of a regular Newsletter.
5. The setting up of Task Forces to:
   a) prepare a report on training facilities, courses, needs, and links with industry;
   b) improve contacts and information exchange with industrial partners;
   c) look into new uses for natural products;
   d) determine the needs for the collection and conservation of germplasm;
   e) promote knowledge of the use of traditional medicine systems.

An invitation is extended to all international organizations with an interest in any aspect of the conservation, sustainable use, production, breeding, selection, processing, pharmacognosy, marketing, or biotechnology of aromatic and medicinal plants and which wishes to participate in the work of the Council to contact the Secretary of ICMAP, Ir. H.H. van der Borg, at the address given above.

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